

# AEROSPACE MEDICINE AND BIOLOGY

A CONTINUING BIBLIOGRAPHY WITH INDEXES

(NASA-SP-7011(388)) AEROSPACE  
MEDICINE AND BIOLOGY: A CONTINUING  
BIBLIOGRAPHY WITH INDEXES  
(SUPPLEMENT 388) (NASA) 59 p

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NASA SP-7011 (388)

May 1994

# **AEROSPACE MEDICINE AND BIOLOGY**

A CONTINUING BIBLIOGRAPHY WITH INDEXES



National Aeronautics and Space Administration  
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Washington, DC

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# INTRODUCTION

This issue of *Aerospace Medicine and Biology* (NASA SP-7011) lists 132 reports, articles, and other documents recently announced in the NASA STI Database. The first issue of *Aerospace Medicine and Biology* was published in July 1964.

Accession numbers cited in this issue include:

Scientific and Technical Aerospace Reports (STAR) (N-10000 Series)

N94-23773 — N94-26332

Open Literature (A-10000 Series)

None in this issue

In its subject coverage, *Aerospace Medicine and Biology* concentrates on the biological, physiological, psychological, and environmental effects to which humans are subjected during and following simulated or actual flight in the Earth's atmosphere or in interplanetary space. References describing similar effects on biological organisms of lower order are also included. Such related topics as sanitary problems, pharmacology, toxicology, safety and survival, life support systems, exobiology, and personnel factors receive appropriate attention. Applied research receives the most emphasis, but references to fundamental studies and theoretical principles related to experimental development also qualify for inclusion.

Each entry in the publication consists of a standard bibliographic citation accompanied in most cases by an abstract. The listing of the entries is arranged by *STAR* categories 51 through 55, the Life Sciences division. The citations include the original accession numbers from the respective announcement journals.

Seven indexes—subject, personal author, corporate source, foreign technology, contract number, report number, and accession number—are included.

A cumulative index for 1994 will be published in early 1995.

Information on availability of documents listed, addresses of organizations, and CASI price schedules are located at the back of this issue.

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# TABLE OF CONTENTS

|                    |                                                                                                                                                      |            |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------|------------|
| <b>Category 51</b> | <b>Life Sciences (General)</b>                                                                                                                       | <b>129</b> |
| <b>Category 52</b> | <b>Aerospace Medicine</b><br>Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.      | <b>133</b> |
| <b>Category 53</b> | <b>Behavioral Sciences</b><br>Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research. | <b>136</b> |
| <b>Category 54</b> | <b>Man/System Technology and Life Support</b><br>Includes human engineering; biotechnology; and space suits and protective clothing.                 | <b>140</b> |
| <b>Category 55</b> | <b>Space Biology</b><br>Includes exobiology; planetary biology; and extraterrestrial life.                                                           | <b>155</b> |

|                                       |              |
|---------------------------------------|--------------|
| <b>Subject Index .....</b>            | <b>A-1</b>   |
| <b>Personal Author Index .....</b>    | <b>B-1</b>   |
| <b>Corporate Source Index .....</b>   | <b>C-1</b>   |
| <b>Foreign Technology Index .....</b> | <b>D-1</b>   |
| <b>Contract Number Index .....</b>    | <b>E-1</b>   |
| <b>Report Number Index .....</b>      | <b>F-1</b>   |
| <b>Accession Number Index .....</b>   | <b>G-1</b>   |
| <b>Appendix .....</b>                 | <b>APP-1</b> |

## TYPICAL REPORT CITATION AND ABSTRACT

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ACCESSION NUMBER → N94-11045\*#      Pennsylvania State Univ., Hershey. Coll. of ← CORPORATE SOURCE  
Medicine.

TITLE → EFFECTS OF CSF HORMONES AND IONIC COMPOSITION ON  
SALT/WATER METABOLISM Final Technical Report, 1 Mar.  
1981 - 31 Dec. 1992

AUTHOR → WALTER B. SEVERS      31 Dec. 1992      32 p      ← PUBLICATION DATE

CONTRACT NUMBER → (Contract NCC2-127)

REPORT NUMBERS → (NASA-CR-193232; NAS 1.26:193232)      Avail: CASI HC A03/MF ← AVAILABILITY AND  
A01      PRICE CODE

The consequences of headward fluid shifts during manned spaceflight was studied. Such shifts were recognized early by both U.S. and Soviet scientists because of signs and symptoms referable to the head. Some of these include disturbed vision, puffiness in the face and periorbital areas, headache, vestibular dysfunction, and distended jugular veins. We posited that the fluid shift had an immediate effect on the brain and a long-term action requiring a neural interpretation of the flight environment. This would re-adjust both efferent neural as well as hormonal mechanisms to sustain cardiovascular and fluid/electrolyte balance consonant with survival in microgravity. Work along these lines is summarized. A synopsis of some of the main research is presented. The following topics were studied: (1) angiotensin and vasopressin action in the central nervous system; (2) intracranial pressure control; (3) research on subcommissural organ; and (4) research on the eye.

Author (revised)

## TYPICAL JOURNAL ARTICLE CITATION AND ABSTRACT

ACCESSION NUMBER → A94-11095

TITLE → SEA-LEVEL P(CO<sub>2</sub>) RELATES TO VENTILATORY  
ACCLIMATIZATION AT 4,300 M

AUTHORS → JOHN T. REEVES, ROBERT E. MCCULLOUGH, LORNA G.  
MOORE, ALLEN CYMERMAN, and JOHN V. WEIL (Colorado Univ., ← AUTHORS' AFFILIATION  
Denver; U.S. Army, Research Inst. of Environmental Medicine,  
Natick, MA) Journal of Applied Physiology (ISSN 8750-7587) ← JOURNAL TITLE  
vol. 75, no. 3 Sept. 1993 p. 1117-1122. refs ← PUBLICATION DATE

CONTRACT NUMBERS → (Contract DAMD81-C-1057; DAMD17-91-C-1112; NIH-HL-14985)  
Copyright

The hypothesis of Hirshman et al. (1978) and Weil (1986) that the large (over an eightfold range) individual variations in the strength of the hypoxic ventilatory response (HVR) observed in the laboratory are related to ventilatory acclimatization to altitude was tested. End-tidal P(CO<sub>2</sub>) values were measured in 37 resting subjects at sea level (showing a 34-48 Torr range) and after the subjects were taken to Pikes Peak (4300 m), with measurements made on arrival and repeatedly over 19 days. It was found that, at 4300 m, subjects with high end-tidal P(CO<sub>2</sub>) had low values of arterial oxygen saturation, Sa(O<sub>2</sub>), and that sea-level end-tidal P(CO<sub>2</sub>) related to Sa(O<sub>2</sub>) after 19 days at 4300 m. The end-tidal P(CO<sub>2</sub>) values on arrival and after 19 days at 4300 m were inversely related to the sea-level HVR values.

AIAA

## LIFE SCIENCES (GENERAL)

### **N94-24124\*# Arizona Univ., Tucson. Dept. of Biochemistry. SKELETAL MUSCLE METABOLISM IN HYPOKINETIC RATS**

**Final Technical Report, Jul. 1981 - Dec. 1993**

MARC E. TISCHLER 1993 10 p

(Contract NAGW-227; NAG2-384)

(NASA-CR-195082; NAS 1.26:195082) Avail: CASI HC A02/MF A01

This grant focused on the mechanisms of metabolic changes associated with unweighting atrophy and reduced growth of hind limb muscles of juvenile rats. Metabolic studies included a number of different areas. Amino acid metabolic studies placed particular emphasis on glutamine and branched-chain amino acid metabolism. These studies were an outgrowth of understanding stress effects and the role of glucocorticoids in these animals. Investigations on protein metabolism were largely concerned with selective loss of myofibrillar proteins and the role of muscle proteolysis. These investigations lead to finding important differences from denervation and atrophy and to define the roles of cytosolic versus lysosomal proteolysis in these atrophy models. A major outgrowth of these studies was demonstrating an ability to prevent atrophy of the unweighted muscle for at least 24 hours. A large amount of work concentrated on carbohydrate metabolism and its regulation by insulin and catecholamines. Measurements focused on glucose transport, glycogen metabolism, and glucose oxidation. The grant was used to develop an important new in situ approach for studying protein metabolism, glucose transport, and hormonal effects which involves intramuscular injection of various agents for up to 24 hours. Another important consequence of this project was the development and flight of Physiological-Anatomical Rodent Experiment-1 (PARE-1), which was launched aboard Space Shuttle Discovery in September 1991. Detailed descriptions of these studies can be found in the 30 peer-reviewed publications, 15 non-reviewed publications, 4 reviews and 33 abstracts (total 82 publications) which were or are scheduled to be published as a result of this project. A listing of these publications grouped by area (i.e. amino acid metabolism, protein metabolism, carbohydrate metabolism, and space flight studies) are included. Author

### **N94-24290# National Defence Research Establishment, Umea (Sweden). Microbiology Div.**

#### **MICROINJECTION OF THE YERSINIA YOPE CYTOTOXIN IN MAMMALIAN CELLS INDUCES ACTIN MICROFILAMENT DISRUPTION**

ROLAND ROSQVIST, AAKE FORSBERG, and HANS WOLF-WATZ (Umea Univ., Sweden.) 1991 2 p Repr. from Biochemical Society Transactions, v. 19, 1991 p 113-114

(Contract SMRC-07-490-5A; BU-4426-301; STUF-90-005-770)

(FOA-B-40418-4.4; ETN-93-93763) Avail: CASI HC A01

Pathogenic *Yersinia* possess a common virulence plasmid of about 70 kb in size. Upon incubation at 37 C in the absence of  $Ca^{2+}$  ions, strains harboring the plasmid stop growing and start producing a number of proteins denoted Yops (*Yersinia* outer

membrane proteins). Results and discussions of an experiment which showed that secreted Yops can induce cytotoxicity in cultured cells if the proteins are delivered inside the cell by microinjection are given. Furthermore, the intracellular target of this cytotoxic effect is essential for maintenance of normal actin microfilament structure. It is concluded that YopE is a cytotoxin which mediates disruption of actin microfilaments, and YopD is involved in the translocation of YopE through the host membrane. ESA

### **N94-24294 Materials Research Labs., Ascot Vale (Australia). Defence Science and Technology Organisation.**

#### **INTERACTION OF TACRINE AT M(1) AND M(2)**

#### **CHOLINOCEPTORS IN GUINEA PIG BRAIN**

MARIA SZILAGYI and WAI-MAN LAU Switzerland S. Karger AG, Basel, Switzerland 1993 7 p Repr. from Pharmacology 1993, v. 47, p 223-229

Copyright Avail: Issuing Activity

Tacrine (THA) actively modulates binding of M(sub 1) ligands in an allosteric fashion causing positive cooperativity. The binding affinity of THA to M(sub 1) and M(sub 2) cholinergic receptors is similar. It is therefore proposed that the allosteric selectivity of THA is a function of the binding site and not of THA itself. Its interaction of M(sub 1) and M(sub 2) cholinergic receptors was examined in guinea pig brain homogenates using the selective M(sub 1) and M(sub 2) antagonists (3H)-pirenzepine ((3H)PZ) and (3H)AF-DX 384. The dissociation constants were 0.36 nmol/l for the M(sub 1) receptor and 0.23 nmol/l for the M(sub 2) receptor. The binding of THA and methoctramine (MTA) at M2 receptors were also compared. Tacrine displayed similar binding affinity for both M(sub 1) and M(sub 2) receptor subtypes. MTA was 100 times more potent an inhibitor of (3H)AF-DX 384 binding at M(sub 2) receptors than THA. In addition, THA was found to slow the dissociation of (3H)PZ from the M(sub 1) receptor. In contrast, the dissociation of (3H)AF-DX 384 from M(sub 2) receptor subtypes was unaffected. It was concluded that THA acts as an agonist at M(sub 1) cholinergic receptors because it slowed the dissociation of (3H)PZ. At M(sub 2) cholinergic receptors its nature is that of an antagonist because it had no effect on (3H)AF-DX 384 dissociation. Author (revised)

### **N94-24310\*# Sverdrup Technology, Inc., Huntsville, AL.**

#### **MICROBIOLOGICAL ANALYSIS OF DEBRIS FROM SPACE TRANSPORTATION SYSTEM (STS)-55 SPACELAB D-2 Final Report**

T. L. HUFF Jan. 1994 10 p

(Contract NAS8-37814)

(NASA-CR-193883; NAS 1.26:193883) Avail: CASI HC A02/MF A01

Filter debris from the Spacelab module D-2 of STS-55 was analyzed for microbial contamination. Debris from cabin and avionics filters was collected by Kennedy Space Center personnel on May 8, 1993, 2 days postflight. Debris weights were similar to those of previous Spacelab missions. Approximately  $5.1E+5$  colony forming units per gram of debris were enumerated from the cabin and avionics filter debris, respectively. These numbers were similar in previous missions for which the entire contents were analyzed without sorting of the material. Bacterial diversity was small compared to previous missions, with no gram negative bacteria isolated. Only one bacterial species, *Corynebacterium pseudodiphtheriticum*, was not isolated previously by the laboratory from Spacelab debris. This organism is a normal inhabitant of the



## 51 LIFE SCIENCES (GENERAL)

pharynx. A table listing all species of bacteria isolated by the laboratory from previous Spacelab air filters debris collection is provided. Author

**N94-24426\*#** Alabama Univ., Huntsville. Dept. of Biological Sciences.

### MEASURING THE DYNAMICS OF STRUCTURAL CHANGES IN BIOLOGICAL MACROMOLECULES FROM LIGHT SCATTERING DATA

ADRIEL D. JOHNSON *In its* The 1993 NASA/ASEE Summer Faculty Fellowship Program 3 p Nov. 1993  
Avail: CASI HC A01/MF A03

Examining techniques to study the dynamics of structural changes in various molecules has been an ongoing goal of the space program. Knowing how these phenomena occur in biological systems is fundamental to understanding what is necessary for life to remain functional in the space environment. A hierarchy of biological organization is functionally described when cells join together small organic molecules to form larger and more complex molecules. Characterizing the architecture of a particular macromolecule helps determine how that molecule works in the living cell and is basic to the diversity of life. Understanding this arrangement involves the correlation of the structure of macromolecules with their functions. A light scattering photometer was developed for detecting continuous measurement of the angular spectrum of light scattered by dynamically changing systems. The analysis of light scattered by biological macromolecules can be used to determine concentration, size, shape, molecular weight, and structural changes of cells, such as erythrocytes. Some light scattering photometers can collect and store 120 angular scattering spectra per minute, with an angular resolution of 0.2 deg which can be displayed with computer graphics. The light scattering photometer does the following: functions to produce and detect scattered light; determines scatter angles; and collects, stores, and analyzes data. Author (revised)

**N94-24437\*#** Alabama Univ., Huntsville. Dept. of Biological Sciences.

### EVALUATION OF OVOSTATIN AND OVOSTATIN ASSAY

DEBRA M. MORIARTY *In its* The 1993 NASA/ASEE Summer Faculty Fellowship Program 5 p Nov. 1993  
Avail: CASI HC A01/MF A03

Ovostatin is a 780,000 MW protein, originally isolated from chicken egg white, which is active as a protease inhibitor. Structural studies indicate that the protein is a tetramer of identical subunits of 165,000 MW which can be separated upon reduction with beta-mercaptoethanol. Chicken ovostatin is an inhibitor of metalloproteases such as collagenase and thermolysin, and of acid proteases such as pepsin and rennin. Ovostatin isolated from duck eggs and from crocodile eggs appears to be similar to chicken egg ovostatin, but with significant differences in structure and function. Duck ovostatin contains a reactive thiol ester which is not found in the chicken protein, and duck and crocodile ovostatin inhibit serine protease such as trypsin and chymotrypsin, while chicken ovostatin does not. Electron microscopy of ovostatin indicates that two subunits associated near the middle of each polypeptide to form a dimer with four arms. Two of these dimers then associate to produce a tetramer with eight arms, with the protease binding site near the center of the molecule. Upon binding of the protease, a conformational change causes all eight arms to curl toward the center of the molecule, effectively trapping the protease and sterically hindering access of the substrates to its active site. The structural organization and mechanism of action proposed for ovostatin are nearly identical to that proposed for alpha(sub 2)-macroglobulin, a serum protease inhibitor which may play an important role in regulation of proteases in animal tissues. Although the general arrangement of subunits appears to be the same for all ovostatins studied, some differences have been observed, with chicken ovostatin more closely resembling reptilian ovostatin than the duck protein. This is a surprising result, given the evolutionary relatedness of chickens and ducks. It is possible that the differences in structures may be due to deformed subunit arrangements which occur during the processing and fixing

necessary for electron microscopy. Examination of the native structure of these proteins using X-ray crystallography would help clarify these discrepancies. Derived from text

**N94-24688** SRI International Corp., Menlo Park, CA.

### IN VITRO SYSTEM FOR STUDYING METABOLISM OF ENVIRONMENTAL CHEMICALS IN HUMAN CELLS Annual Report, 30 Apr. 1992 - 29 Apr. 1993

CAROL E. GREEN 5 Nov. 1993 32 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract F49620-91-C-0050)

(AD-A273427; AFOSR-93-0854TR) Avail: CASI HC A03

The objective of the project is to establish and use an in vitro system of intact hepatocytes from rodent and human tissues to develop quantitative data on the metabolism of toxic chemicals that can be used in risk assessments. Currently, two different in vitro models are most frequently used for comparative metabolism studies-isolated hepatocytes and precision-cut liver slices. In the second year of the project, hepatocytes and liver slices from rat and human livers were compared to determine their capability to metabolize chloroform and a model substrate, 7-ethoxycoumarin. The 7-ethoxycoumarin O-deethylation activity of hepatocytes was consistently higher than the activity measured with liver slices, when standardized by protein content of the two preparations. The metabolism of chloroform by hepatocytes isolated from male F344 rats was characterized by analyzing headspace and medium concentrations. The kinetic constants, estimated from the headspace data generated in these experiments, are  $K_m = 34$  nmol/flask and  $V_{max} = 24$  pmol/min/106 cells. Headspace analysis was also useful for determining chloroform metabolism by liver slices. After addition of 3.6 nmol/flask, the rate of chloroform loss was 2.5 pmol/min/mg tissue. DTIC

**N94-24704** National Academy of Sciences - National Research Council, Washington, DC.

### A BIOLOGICAL SURVEY FOR THE NATION

1993 211 p

(LC-93-85920; ISBN-0-309-04984-0) Copyright Avail: Issuing Activity

The idea of a national biological survey has a long history in the United States. In recent years, increasing concerns about the nation's biological resources have led to calls for a new biological survey. Recently, the process of forming a National Biological Survey (NBS) within the Department of the Interior (DOI) was initiated. A research agenda for the NBS is proposed that is far broader than the existing research effort in DOI but that is also focused according to likely immediate and long-term user needs. A National Biotic Resources Information System is envisioned to make reliable biological information more accessible to diverse users. Also described is how the many public and private entities involved in current research on biological resources can work together in a new entity, which the committee has called the National Partnership for Biological Survey, to provide comprehensive information that will be useful for decision-makers at all levels of government and outside government.

Derived from text

**N94-24791#** University of Southern California, Los Angeles. Dept. of Biological Sciences.

### SYMBIOSIS IN MARINE LUMINOUS BACTERIA Final Report

EDWARD G. RUBY 1993 3 p

(Contract N00014-92-J-1716)

(AD-A273540) Avail: CASI HC A01/MF A01

This work indicates that the distribution and abundance of a class of marine microorganisms, the symbiotic luminous bacteria, are controlled by the dynamics of their relationship with their host. Such a conclusion constitutes the first time that the ecology of any marine bacterium could be related to a predictive biological factor. This study also points to the presence of a significant population of typically culturable *V. fischeri* cells in seawater that have entered a non-culturable state from which they can be recovered only through an association with a specific animal tissue.

Such a phenomenon changes the way we view the initiation of the light organ symbiosis. However, of even broader interest, it suggests that at least a portion of the 99.9% of bacteria in seawater that can not be cultured may not be unknown or new species, but in fact are well-known, typically culturable bacteria that are awaiting a specific environmental cue that signals these cells to re-enter a proliferative stage in their cell cycle. DTIC

**N94-24807\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**THE EVOLUTION OF ENERGY-TRANSDUCING SYSTEMS. STUDIES WITH AN EXTREMELY HALOPHILIC**

**ARCHAEBACTERIUM Final Report, Feb. 1989 - Aug. 1992**

HELGA STAN-LOTTER Aug. 1992 11 p

(Contract NCC2-578)

(NASA-CR-193803; NAS 1.26:193803) Avail: CASI HC A03/MF A01

The F-type ATPases are found in remarkably similar versions in the energy-transducing membranes of eubacteria, chloroplasts, and mitochondria. Thus, it is likely that they have originated early in the evolution of life, which is consistent with their function as key enzymes of cellular metabolism. The archaeobacteria are a group of microorganisms which, as shown by molecular sequencing and biochemical data, have diverged early from the main line of prokaryotic evolution. From studies of members of all three major groups of archaeobacteria - the halophiles, methanogens, and thermoacidophiles - it emerged that they possess a membrane ATPase which differs from the F-ATPases. The goal of this project was a comparison of the ATPase from the halophilic archaeobacterium *Halobacterium saccharovorum* with the well-characterized F-type ATPases on the molecular level. Amino acid sequences of critical regions of the enzyme were to be determined, as well as immunoreactions of single subunits in the search for common epitopes. The results were expected to allow a decision about the nature of archaeobacterial ATPases, their classification as one of the known or, alternatively, novel enzyme complexes, and possibly deduction of events during the early evolution of energy-transducing systems. Derived from text

**N94-24810\*#** Florida Univ., Gainesville. Dept. of Aerospace Engineering, Mechanics and Engineering Science.

**BIOREGENERATIVE LIFE SUPPORT SYSTEMS FOR MICROGRAVITY**

GAIL E. NEVILL, JR., MICHAEL I. HESSEL, JR., JOSE RODRIGUEZ, and STEVE MORGAN, ed. Apr. 1993 72 p

(Contract NASW-4435)

(NASA-CR-195516; NAS 1.26:195516) Avail: CASI HC A04/MF A01

NASA's Controlled Ecological Life Support System (CELSS) project centers on growing plants and recycling wastes in space. The current version of the biomass production chamber (BPC) uses a hydroponic system for nutrient delivery. To optimize plant growth and conserve system resources, the content of the nutrient solution which feeds the plants must be constantly monitored. The macro-nutrients (greater than ten ppm) in the solution include nitrogen, phosphorous, potassium, calcium, magnesium, and sulphur; the micro-nutrients (less than ten ppm) include iron, copper, manganese, zinc, and boron. The goal of this project is to construct a computer-controlled system of ion detectors that will accurately measure the concentrations of several necessary ions in solution. The project focuses on the use of a sensor array to eliminate problems of interference and temperature dependence.

Derived from text

**N94-24811\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**THE EVOLUTION OF ENERGY-TRANSDUCING SYSTEMS. STUDIES WITH ARCHAEBACTERIA Semiannual Progress Report, Sep. 1993 - Feb. 1994**

HELGA STAN-LOTTER Feb. 1994 5 p

(Contract NCC2-578)

(NASA-CR-195129; NAS 1.26:195129) Avail: CASI HC A01/MF A01

N-ethylmaleimide (NEM) inhibits the ATPase of *H. saccharovorum* in a nucleotide protectable manner. The bulk of C-14 NEM is incorporated into subunit one. Cyanogen bromide cleavage of labeled subunit one indicated that NEM bound to a peptide of a Mr of about 8,900. Thus, Cys 262 (*H. salinarum* numbering) may be the NEM binding site. Cyanogen bromide fragments have been submitted for sequencing. To prove the presence of three Cys residues in subunit one, alkaline cleavage following treatment with NTCB was carried out. Thiol reagents such as p-chloro mercuri phenyl sulfonate also inhibited the ATPase. However, this inhibition was not nucleotide-protectable, suggesting a different location and role for the PCMS-sensitive Cys. The proteolipid which was extracted with chloroform/methanol from the membranes of *H. saccharovorum* cross-reacted with an antiserum against subunit c (the DCCD-binding protein) of *Escherichia coli*. Following labeling of membranes from *H. saccharovorum* with C-14 DCCD under conditions, which inhibited ATP synthesis, the isotope was incorporated into one protein of Mr of about 6,500. Thus, the proteolipid of *H. saccharovorum* and the DCCD-labeled peptide may be identical. If so, these results suggest that the proteolipid is a component of the membrane sector of an archaeal F-type ATP synthase. Author (revised)

**N94-25146#** Naval Postgraduate School, Monterey, CA. Dept. of Operations Research.

**AN EXPLORATORY STOCHASTIC MODEL FOR TOXIC EFFECTS ON CELLS**

R. L. CARPENTER, D. P. GAVER, and P. A. JACOBS Sep. 1993 81 p

(AD-A273438; NPS-OR-93-104) Avail: CASI HC A05/MF A01

A multivariate dynamic Markov model is formulated to describe the possible effect of a generic chemical toxin on a generic cell population in an organ. Asymptotic methods (large cell population) are used to show that numbers and toxin may be jointly Gaussian/normally distributed; the joint stochastic process is approximately Ornstein-Uhlenbeck. Application to dose-response, and hence risk analysis, is briefly discussed. DTIC

**N94-25357\*#** Texas A&M Univ., College Station. Bioengineering Program.

**NON-INVASIVE OPTICAL DETECTION OF GLUCOSE IN CELL CULTURE NUTRIENT MEDIUM**

GERALD L. COTE In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 1 11 p Dec. 1993

Avail: CASI HC A03/MF A03

The objective of the proposed research was to begin the development of a non-invasive optical sensor for measuring glucose concentration in the output medium of cell cultures grown in a unique NASA bioreactor referred to as an integrated rotating-wall vessel (IRWV). The input, a bovine serum based nutrient media, has a known glucose concentration. The cells within the bioreactor digest a portion of the glucose. Thus, the non-invasive optical sensor is needed to monitor the decrease in glucose due to cellular consumption since the critical parameters for sustained cellular productivity are glucose and pH. Previous glucose sensing techniques have used chemical reactions to quantify the glucose concentration. Chemical reactions, however, cannot provide for continuous, real time, non-invasive measurement as is required in this application. Our effort while in the fellowship program was focused on the design, optical setup, and testing of one bench top prototype non-invasive optical sensor using a mid-infrared absorption spectroscopy technique. Glucose has a fundamental vibrational absorption peak in the mid-infrared wavelength range at 9.6 micron. Preliminary absorption data using a CO2 laser were collected at this wavelength for water based glucose solutions at different concentrations and one bovine serum based nutrient medium (GTSF) with added glucose. The results showed near linear absorption responses for the glucose-in-water data with resolutions as high as 108 mg/dl and as low as 10 mg/dl. The nutrient medium had a resolution of 291 mg/dl. The variability of the results was due mainly to thermal and polarization drifts of

## 51. LIFE SCIENCES (GENERAL)

the laser while the decrease in sensitivity to glucose in the nutrient medium was expected due to the increase in the number of confounders present in the nutrient medium. A multispectral approach needs to be used to compensate for these confounders. The CO<sub>2</sub> laser used for these studies was wavelength tunable (9.2 to 10.8 micrometers), however, it was to unstable across wavelengths to test the multispectral approach. From this research, further NASA support was obtained to continue the work throughout the year in which a more stable light source will be used at smaller, near-infrared, wavelengths. It is anticipated that a more compact, non-invasive, optical glucose sensor will be realized which can be used with a bioreactor on future space shuttle missions. It is also anticipated that a multispectral optical sensor may be used to determine the concentration of other molecules needed within the NASA bioreactor, such as fructose and galactose. Author

**N94-25368\*** # Houston Univ., Clear Lake, TX. Div. of Biology.

### **DESIGN AND TESTING OF A UNIQUE RANDOMIZED GRAVITY, CONTINUOUS FLOW BIOREACTOR**

CARROLL B. LASSITER /in NASA, Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 15 p Dec. 1993  
Avail: CASI HC A03/MF A03

A rotating, null gravity simulator, or Couette bioreactor was successfully used for the culture of mammalian cells in a simulated microgravity environment. Two limited studies using *Lipomyces starkeyi* and *Streptomyces clavuligerus* were also conducted under conditions of simulated weightlessness. Although these studies with microorganisms showed promising preliminary results, oxygen limitations presented significant limitations in studying the biochemical and cultural characteristics of these cell types. Microbial cell systems such as bacteria and yeast promise significant potential as investigative models to study the effects of microgravity on membrane transport, as well as substrate induction of inactive enzyme systems. Additionally, the smaller size of the microorganisms should further reduce the gravity induced oscillatory particle motion and thereby improve the microgravity simulation on earth. Focus is on the unique conceptual design, and subsequent development of a rotating bioreactor that is compatible with the culture and investigation of microgravity effects on microbial systems. The new reactor design will allow testing of highly aerobic cell types under simulated microgravity conditions. The described reactor affords a mechanism for investigating the long term effects of reduced gravity on cellular respiration, membrane transfer, ion exchange, and substrate conversions. It offers the capability of dynamically altering nutrients, oxygenation, pH, carbon dioxide, and substrate concentration without disturbing the microgravity simulation, or Couette flow, of the reactor. All progeny of the original cell inoculum may be acclimated to the simulated microgravity in the absence of a substrate or nutrient. The reactor has the promise of allowing scientists to probe the long term effects of weightlessness on cell interactions in plants, bacteria, yeast, and fungi. The reactor is designed to have a flow field growth chamber with uniform shear stress, yet transfer high concentrations of oxygen into the culture medium. The system described allows for continuous, on line sampling for production of product without disturbing fluid and particle dynamics in the reaction chamber. It provides for the introduction of substrate, or control substances after cell adaptation to simulated microgravity has been accomplished. The reactor system provides for the nondisruptive, continuous flow replacement of nutrient and removal of product. On line monitoring and control of growth conditions such as pH and nutrient status are provided. A rotating distribution valve allows cessation of growth chamber rotation, thereby preserving the simulated microgravity conditions over longer periods of time.

Author (revised)

**N94-25593#** Edgewood Arsenal, Aberdeen Proving Ground, MD. Research Development and Engineering Center.

### **PROCEEDINGS OF THE SYMPOSIUM ON CURRENT CONCEPTS AND APPROACHES ON ANIMAL TEST**

**ALTERNATIVES** Final Report, period ending Feb. 1992

HARRY SALEM, comp. Sep. 1993 407 p

(Contract DA PROJ. 101-62622-A-553)

(AD-A273926; ERDEC-SP-012) Avail: CASI HC A18/MF A04

Biological and medical research has historically been conducted primarily with animal experimentation. The advances in biological scientific knowledge and medicine have been dependent and resulted from these animal experiments, supplemented with in vitro studies. Over the last decade, advocates for animal rights, and the skyrocketing cost of animal experimentation, have intensified the search for more alternatives to animal biomedical research and testing. Although to replace animal research is a noble quest, realistically this may never be accomplished since the final proof will require testing in an integrated whole animal system. However, the scientific and animal activist communities, sensitive to all of these issues, are advocating the adoption of three goals: replacement of animals, reduction in the number of animals, and refinement by getting more information from fewer animals and using animals lower on the phylogenetic tree. A fourth task is taking responsibility for implementation. These proceedings describe the current state of the art in these approaches. Alternative methods (in vitro, chemical, computer) are described for not only eye and skin, but also for inhalation, aquatic, environmental and noncarcinogenic endpoints. In addition, the regulatory status is discussed since this is a major prerequisite to validation and acceptance.

DTIC

**N94-25672\*** # Colorado Univ., Boulder. Dept. of Aerospace Engineering Sciences.

### **AUTONOMOUS SUPPORT FOR MICROORGANISM RESEARCH IN SPACE**

M. W. LUTTGES, D. M. KLAUS, M. L. FLEET, M. S. MILLER, D. E. SHIPLEY, and J. D. SMITH /in USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 40-52 1992

Avail: CASI HC A03/MF A04

A preliminary design for performing on-orbit, autonomous research on microorganisms and cultured cells/tissues is presented. An understanding of gravity and its effects on cells is crucial for space exploration as well as for terrestrial applications. The payload is designed to be compatible with the COMMERCE Experiment Transported (COMET) launch vehicle, an orbiter middeck locker interface, and with Space Station Freedom. Uplink/downlink capabilities and sample return through controlled reentry are available for all carriers. Autonomous testing activities are preprogrammed with inflight reprogrammability. Sensors for monitoring temperature, pH, light, gravity levels, vibration, and radiation are provided for environmental regulation and experimental data collection. Additional experiment data acquisition includes optical density measurement, microscopy, video, and file photography. Onboard full data storage capabilities are provided. A fluid transfer mechanism is utilized for inoculation, sampling, and nutrient replenishment of experiment cultures. In addition to payload design, representative experiments were developed to ensure scientific objectives remained compatible with hardware capabilities. The project is defined to provide biological data pertinent to extended duration crewed space flight including crew health issues and development of a Controlled Ecological Life Support System (CELSS). In addition, opportunities are opened for investigations leading to commercial applications of space, such as pharmaceutical development, modeling of terrestrial diseases, and material processing.

Author

**N94-25673\*** # Florida Univ., Gainesville. Dept. of Aerospace Engineering, Mechanics and Engineering Sciences.

### **BIOGENERATIVE SYSTEM COMPONENTS FOR MICROGRAVITY**

GALE E. NEVILL, JR. and MICHAEL I. HESSEL, JR. /in USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 53-66 1992

Avail: CASI HC A03/MF A04

The goal of the class was to design, fabricate, and test prototype designs that were independent, yet applicable to a Closed Loop Life Support System. The three prototypes chosen were in

the areas of agar plant growth, regenerative filtration, and microgravity food preparation. The plant growth group designed a prototype agar medium growth system that incorporates nutrient solution replenishment and post-harvest refurbishment. In addition, the unit emphasizes material containment and minimization of open interfaces. The second project was a filter used in microgravity that has the capability to clean itself. The filters are perforated plates which slide through a duct and are cleaned outside of the flow with a vacuum system. The air in the duct is prevented from flowing outside of the duct by a network of sliding seals. The food preparation group developed a device which dispenses and mixes ingredients and then cooks the mixture in microgravity. The dry ingredients are dispensed from a canister by a ratchet-operated piston. The wet ingredients are dispensed from plastic bags through tubing attached to a syringe. Once inside the mixing chamber, the ingredients are mixed using a collapsible whisk and then pushed into the cooking device. Author

**N94-26086\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**AN AUTOMATIC 14-DAY PASTE DIET FEEDER FOR ANIMALS**  
MARILYN VASQUES, JERRY MULENBURG, DAN GUNDO, and JON GRIFFITH (Bionetics Corp., Moffett Field, CA.) Jan. 1994 13 p

(Contract RTOP 199-08-12-06)

(NASA-TM-108804; A-94037; NAS 1.15:108804) Avail: CASI HC A03/MF A01

During a centrifuge experiment, any interruption that requires stopping the centrifuge may influence the results. Centrifuges often must be stopped for animal maintenance (food, water and waste removal), especially in cases of timed feedings. To eliminate the need for stopping the centrifuge while still providing timed feeding, an automatic paste diet feeder was developed. The feeder is based on a constant volume concept and can deliver a predetermined amount of paste diet at specified time intervals. This unit was supported by water delivery and waste collection systems. The entire system performed reliably and maintained the animals well for a continuous centrifugation experiment of 14 days. Author

**N94-26093\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**PLASMA VOLUME SHIFTS AND EXERCISE  
THERMOREGULATION WITH WATER IMMERSION AND  
SIX-DEGREE HEAD-DOWN TILT**

ANDREW CARL ERTL Jan. 1994 32 p

(Contract NGT-50686; RTOP 199-18-12-07)

(NASA-TM-108781; A-93097; NAS 1.15:108781) Avail: CASI HC A03/MF A01

The hypothesized fluid shifts and resultant responses that occur during spaceflight are simulated by six-degree head down tilt (HDT) and water immersion (WI). The purpose of this study was to compare exercise thermoregulation before and after physiologic mechanisms reduce plasma volume (PV) in response to 24-hr HDT (HDT24). A secondary study utilized WI to reproduce the PV reduction of HDT24. Seven males were studied in two conditions: during 70 minutes of supine cycling ergometry at 58 percent of peak oxygen consumption following 1-hr HDT (HDT1) and HDT24; and up to 6 hr WI at 34.5 C. Plasma volume was reduced by 10.4 percent in HDT24 when compared to HDT1. Pre-exercise rectal temperature,  $T_{\text{sub re}}$ , was an average 0.22 C higher after HDT24. Rectal temperature increased during exercise with no interaction between time and treatment. The reduced PV and elevated pre-exercise  $T_{\text{sub re}}$  had offsetting effects on thermoregulatory mechanisms, suggesting no alteration in the response at a given  $T_{\text{sub re}}$ . Plasma volume was reduced by 4.3 +/- 2.3 percent and 1.1 +/- 1.8 percent following HDT24 and WI, respectively, compared to upright chair rest. Although the reductions in PV were not significantly different, great intra-individual variability was evident. The ability to reproduce PV changes consistently with HDT and WI is limited by this variability. Author (revised)

**N94-26210\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**THERMOREGULATORY EFFECTS OF CAFFEINE INGESTION  
DURING REST AND EXERCISE IN MEN**

NANCY DUNAGAN, JOHN E. GREENLEAF, and CRAIG J. CISAR Jan. 1994 47 p

(Contract RTOP 199-18-12-07)

(NASA-TM-108783; A-93099; NAS 1.15:108783) Avail: CASI HC A03/MF A01

Body temperatures and thermoregulatory responses were measured at rest and during submaximal exercise under normal ambient conditions in 11 aerobically-conditioned men (age = 29.2 +/- 6.2 yr,  $\text{VO}_2(\text{max}) = 3.73 \pm 0.46 \text{ min}(\text{sup } -1)$ , relative body fat = 12.3 +/- 3.7 percent, mean +/- SD) with (CT) and without (NCT) the ingestion of 10 mg of caffeine per kg of body weight. Oxygen uptake ( $\text{VO}_2$ ), heart rate (HR), and rectal ( $T_{\text{sub re}}$ ) and mean skin ( $T_{\text{bar}(\text{sub sk})}$ ) temperatures were recorded for 100 minutes starting one minute after ingestion of caffeine or a placebo. Data were collected throughout 30 minutes of rest (sitting) and the following 70 minutes of sitting leg ergometer exercise using the same constant load ( $1,088 \pm 153 \text{ kgm/min}$ ) in both NCT and CT. The load resulted in a mean relative exercise intensity equal to approximately 68 percent of  $\text{VO}_2(\text{sub max})$ . Skin heat conductance ( $H_{\text{sub sk}}$ ) and sweat rate were calculated. Two-way analysis of covariance revealed no significant (P greater than 0.05) differences between NCT and CT in  $\text{VO}_2$ , HR,  $T_{\text{sub re}}$ ,  $T_{\text{bar}(\text{sub sk})}$ , or  $H_{\text{sub sk}}$ . A dependent t-test indicated no significant difference between NCT and CT in sweat rate. Thus, a high level of caffeine ingestion has no detrimental effects on body temperatures and thermoregulatory responses during moderately heavy exercise in normal ambient conditions. Author (revised)

## 52

### AEROSPACE MEDICINE

Includes physiological factors; biological effects of radiation; and effects of weightlessness on man and animals.

**N94-24093#** Civil Aeromedical Inst., Oklahoma City, OK.

**INDEX TO FAA OFFICE OF AVIATION MEDICINE REPORTS:  
1961 THROUGH 1993 Final Report**

WILLIAM E. COLLINS and MICHAEL E. WAYDA Jan. 1994 72 p

(DOT/FAA/AM-94/1) Avail: CASI HC A04/MF A01

An index to FAA Office of Aviation Medicine Reports (1964-1993) and Civil Aeromedical Institute Reports is presented for those engaged in aviation medicine and related activities. The index lists all FAA aviation medicine reports published from 1961 through 1993: chronologically, alphabetically by author, and alphabetically by subject. Author (revised)

**N94-24102\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**AUTOGENIC-FEEDBACK TRAINING: A POTENTIAL  
TREATMENT FOR POST-FLIGHT ORTHOSTATIC  
INTOLERANCE IN AEROSPACE CREWS**

PATRICIA S. COWINGS, WILLIAM B. TOSCANO (California Univ., Los Angeles.), NEIL E. MILLER (Yale Univ., New Haven, CT.), THOMAS G. PICKERING (Cornell Univ., New York, NY.), and DAVID SHAPIRO (California Univ., Los Angeles.) Sep. 1993 15 p

(Contract RTOP 199-14-12-06)

(NASA-TM-108785; A-93109; NAS 1.15:108785) Avail: CASI HC A03/MF A01

Postflight orthostatic intolerance was identified as a serious biomedical problem associated with long duration exposure to microgravity in space. High priority was given to the development of countermeasures for this disorder which are both effective and practical. A considerable body of clinical research demonstrated

## 52. AEROSPACE MEDICINE

that people can be taught to increase their own blood pressure voluntarily and that this is an effective treatment for chronic orthostatic intolerance in paralyzed patients. The present pilot study was designed to examine the feasibility of adding training in control of blood pressure to an existing preflight training program designed to facilitate astronaut adaptation to microgravity. Using an operant conditioning procedure, Autogenic-Feedback Training (AFT), three men and two women participated in four to nine (15-30 training sessions). At the end of training, the average increase in systolic and diastolic pressure, as well as mean arterial pressures that the subjects made, ranged between 20 and 50 mmHg under both supine and 45 deg head-up tilt conditions. These findings suggest that AFT may be a useful alternative treatment or supplement to existing approaches for preventing postflight orthostatic intolerance. Further, the use of operant conditioning methods for training cardiovascular responses may contribute to the general understanding of the mechanisms of orthostatic intolerance.

Author (revised)

**N94-24227\*#** Essex Corp., Orlando, FL.  
**TRANSFER OF PERCEPTUAL ADAPTATION TO SPACE SICKNESS: WHAT ENHANCES AN INDIVIDUAL'S ABILITY TO ADAPT? Final Report**

9 Aug. 1993 15 p

(Contract NAS9-18035)

(NASA-CR-188256; NAS 1.26:188256) Avail: CASI HC A03/MF A01

The objectives of this project were to explore systematically the determiners of transfer of perceptual adaptation as these principles might apply to the space adaptation syndrome. The perceptual experience of an astronaut exposed to the altered gravitational forces involved in spaceflight shares much with that of the subject exposed in laboratory experiments to optically induced visual rearrangement with tilt and dynamic motion illusions such asvection; and experiences and symptoms reported by the trainee who is exposed to the compellingly realistic visual imagery of flight simulators and virtual reality systems. In both of these cases the observer is confronted with a variety of inter- and intrasensory conflicts that initially disrupt perception, as well as behavior, and also produce symptoms of motion sickness.

Derived from text

**N94-24865** North Carolina Univ., Chapel Hill. Div. of Otolaryngology.

**AUDITORY SPECTRO-TEMPORAL PATTERN ANALYSIS**

**Annual Report, 1 Jan. - 31 Dec. 1993**

JOSEPH W. HALL 31 Dec. 1993 4 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract F40620-93-1-0045)

(AD-A273554; AFOSR-93-0856TR) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The present research is a continuation of an AFOSR-sponsored program that has supported our research on CMR essentially since the discovery of the phenomenon. Over the past six years, the research program has revealed several important findings related to CMR: the phenomenon is based primarily upon an across-frequency analysis of amplitude envelope; all portions of the envelope do not appear to contribute equally to CMR - envelope dips carry the critical information; CMR increases with the number of comodulated noise bands present, with diminishing returns after three bands are present; the presence of non-comodulated bands within a set of comodulated bands can substantially decrease CMR; when auditory grouping principles are applied to segregate the noncomodulated bands from the comodulated bands, CMR can be restored to a significant extent; CMR occurs for FM, but a much smaller magnitude than for AM; and part of the MLD appears to be based upon a process that is essentially identical to CMR.

DTIC

**N94-24928** Aerospace Medical Research Labs., Brooks AFB, TX. Crew Systems Directorate.  
**ARTIFICIAL GRAVITY IN SPACE FLIGHT Interim Report**

RUSSELL R. BURTON 1994 5 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract AF PROJ. 7930)

(AD-A273420; AL/CF-PC-1993-0040) Avail: Issuing Activity (Defense Technical Information Center (DTIC))

The role of G in space using a short-radius centrifuge has operation implications in preventing physiologic deconditioning from weightlessness. The relationship between periodic gravity exposures on simulated weightless effects, once determined systematically, will provide crucial information on the role of gravity as a regulator of physiologic functions.

DTIC

**N94-24945#** Brooke Army Medical Center, Fort Sam Houston, TX.

**ANNUAL RESEARCH PROGRESS REPORT, FISCAL YEAR 1992. VOLUME 2: DEPARTMENT OF CLINICAL INVESTIGATION**

1992 321 p

(AD-A273584) Avail: CASI HC A14/MF A03

Presented are research progress reports of clinical investigations sponsored by Brooke Army Medical Center. Progress reports are grouped by the following categories: animal studies, southwest oncology group, pediatric oncology group, and gynecology oncology group. Progress reports list the investigators, the objectives of the research, the technical approach taken, and progress to date.

CASI

**N94-24950#** Naval Medical Research Inst., Bethesda, MD.

**A STATISTICAL ANALYSIS OF RECENT NAVAL EXPERIMENTAL DIVING UNIT (NEDU) SINGLE-DEPTH HUMAN EXPOSURES TO 100 PERCENT OXYGEN AT PRESSURE Technical Report, 1987 - 1991**

A. L. HARABIN and S. S. SURVANSKI Oct. 1993 28 p

(Contract NMRI PROJ. M00-99)

(AD-A273488; NMRI-93-59) Avail: CASI HC A03/MF A01

Using the data from 688 human, single-depth, hyperbaric oxygen (O<sub>2</sub>) exposures conducted at the Naval Experimental Diving Unit and reported on from 1979-1986, we developed a mathematical model that can predict the risk of developing symptoms of central nervous system O<sub>2</sub> toxicity as a function of time and depth of exposure. Maximum likelihood analysis with models relating depth and time of exposure to risk accumulation was used to estimate probability of symptom development and confidence intervals. U.S. Navy single depth-time O<sub>2</sub> diving limits were evaluated for safety as a function of actual PO<sub>2</sub> achieved in the breathing apparatus. These results suggest that current limits are not of equal risk. Long shallow exposures might present unacceptably high risk if an FIO<sub>2</sub> = 1.0 were achieved in the breathing rig. Adherence to current recommended purging procedures results in acceptably low (less than 1%) risk predictions for all depths.

DTIC

**N94-25359\*#** Tulane Univ., New Orleans, LA. Dept. of Mechanical Engineering.

**LOADING, ELECTROMYOGRAPH, AND MOTION DURING EXERCISE**

FERNANDO FIGUEROA In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 1 11 p Dec. 1993

Avail: CASI HC A03/MF A03

A system is being developed to gather kineto-dynamic data for a study to determine the load vectors applied to bone during exercise on equipment similar to that used in space. This information will quantify bone loading for exercise countermeasures development. Decreased muscle loading and external loading of bone during weightlessness results in cancellous bone loss of 1 percent per month in the lower extremities and 2 percent per month in the calcaneus. It is hypothesized that loading bone appropriately during exercise may prevent the bone loss. The system consists of an ergometer instrumented to provide position of the pedal (foot), pedaling forces on the foot (on the sagittal

plane), and force on the seat. Accelerometers attached to the limbs will provide acceleration. These data will be used as input to an analytical model of the limb to determine forces on the bones and on groups of muscles. EMG signals from activity in the muscles will also be used in conjunction with the equations of mechanics of motion to be able to discern forces exerted by specific muscles. The tasks to be carried out include: design of various mechanical components to mount transducers, specification of mechanical components, specification of position transducers, development of a scheme to control the data acquisition instruments (TEAC recorder and optical encoder board), development of a dynamic model of the limbs in motion, and development of an overall scheme for data collection analysis and presentation. At the present time, all the hardware components of the system are operational, except for a computer board to gather position data from the pedals and crank. This board, however, may be put to use by anyone with background in computer based instrumentation. The software components are not all done. Software to transfer data recorded from the EMG measurements is operational, software to drive the optical encoder card is mostly done. The equations to model the kinematics and dynamics of motion of the limbs have been developed, but they have not yet been implemented in software. Aside from the development of the hardware and software components of the system, the methodology to use accelerometers and encoders and the formulation of the appropriate equations are an important contribution to the area of biomechanics, particularly in space applications.

Author

**N94-25376\*#** Saint Louis Univ., MO. School of Nursing.  
**DEVELOPMENT OF A MODEL TO ASSESS ORTHOSTATIC RESPONSES**

MARILYN RUBIN /n NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 15 p Dec. 1993  
 Avail: CASI HC A03/MF A03

A major change for crewmembers during weightlessness in microgravity is the redistribution of body fluids from the legs into the abdomen, thorax, and head. The fluids continue to be sequestered in these areas throughout the flight. Upon reentry into gravity on landing, these same body fluids are displaced again to their normal locations, however, not without hazardous incidence to the crewmembers. The problem remains that upon landing, crewmembers are subject to orthostasis, that is, the blood flowing into the legs reduces the blood supply to the brain and may result in the crewmember fainting. The purpose of this study was to develop a model of testing orthostatic responses of blood pressure regulating mechanisms of the cardiovascular system, when challenged, to maintain blood pressure to the brain. To accomplish this, subjects' responses were assessed as they proceeded from the supine position of progressive head-up tilt positions of 30 deg, 60 deg, and 90 deg angles. A convenience sample consisted of 21 subjects, females (N=11) and males (N=10), selected from a list of potential subjects available through the NASA subject screening office. The methodology included all non-invasive measurements of blood pressure, heart rate, echocardiograms, cardiac output, cardiac stroke volume, fluid shifts in the thorax, ventricular ejection and velocity times, and skin blood perfusion. The Fischer statistical analysis was done of all data with the significance level at .05. Significant differences were demonstrated in many instances of changes of posture for all variables. Based on the significance of the findings of this study, this model for assessing orthostatic responses does provide an adequate challenge to the blood pressure regulatory systems. While individuals may use different adaptations to incremental changes in gravity, the subjects, in aggregate, demonstrated significant adaptive cardiovascular changes to orthostatic challenges which were presented to them.

Author

**N94-25378\*#** Akron Univ., OH. Biomedical Engineering.  
**EVALUATION OF BIOIMPEDANCE FOR THE MEASUREMENT OF PHYSIOLOGIC VARIABLES AS RELATED TO HEMODYNAMIC STUDIES IN SPACE FLIGHT**

BRUCE C. TAYLOR /n NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 15 p Dec. 1993  
 Avail: CASI HC A03/MF A03

Orthostatic intolerance, following space flight, has received substantial attention because of the possibility that it compromises astronaut safety and reduces the ability of astronauts to function at peak performance levels upon return to a one-g environment. Many pre- and post-flight studies are performed to evaluate changes in hemodynamic responses to orthostatic challenges after shuttle missions. The purpose of this present project is to validate bioimpedance as a means to acquire stroke volume and other hemodynamic information in these studies. In this study, ten male and ten female subjects were subjected to simultaneous measurements of thoracic bioimpedance and Doppler ultrasonic velocimetry under supine, 10 degree head down and 30 degree head up conditions. Paired measurements were made during six periods of five seconds breath holding, over a two minute period, for each of the three positions. Stroke volume was calculated by three bioimpedance techniques and ultrasonic Doppler.

Author (revised)

**N94-25380\*#** Alabama Univ., Huntsville. Dept. of Engineering Science and Mechanics.

**LOADING, ELECTROMYOGRAPH, AND MOTION DURING EXERCISE**

BETH A. TODD /n NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 11 p Dec. 1993  
 Avail: CASI HC A03/MF A03

A bicycle ergometer system has been developed to determine forces acting in specific muscles and muscle groups for both cycling and isometric exercise. The bicycle has been instrumented with encoders, accelerometers, and load cells. A harnessing system has been developed to keep subjects in place during isometric exercise. EMG data will also be collected with electrodes attached to various muscles on the subject's leg. Data has been collected for static loading and will be collected for cycling in both an earth-based laboratory and on the KC-135. Once the data is analyzed, the forces will be entered into finite element models of bones of the lower extremities. A finite element model of the tibia-fibula has been generated from the experimental subject's MRI data. The linear elastic isoparametric brick elements representing the bones are connected by linear elastic isoparametric shell elements placed at the locations of ligaments. Models will be generated for the calcaneus and the femur. Material properties for the various tissues will be taken from the literature. The experimentally determined muscle forces will be applied to the models to determine the stress distribution which is created in the bones.

Author

**N94-25871#** Institute for Perception RVO-TNO, Soesterberg (Netherlands).

**ENDOGENEOUS AND EXOGENOUS CONTROL OF VISUAL SELECTION: A REVIEW OF THE LITERATURE Final Report**

J. THEEUWES 15 Jul. 1993 23 p  
 (AD-A273761; IZF-1993-B-9; TDCK-TD-93-1361) Avail: CASI HC A03/MF A01

Among the most fundamental issues of visual attention research is the extent to which visual selection is controlled by properties of the stimulus or by the intentions, goals, and beliefs of the observer. Before selective attention operates, preattentive processes perform some basic analyses segmenting the visual field into functional perceptual units. The crucial question is whether the allocation of attention to these perceptual units is under the endogenous control of the observer (intentions, goals, beliefs) or under the exogenous control of stimulation. This report discusses



## 52 AEROSPACE MEDICINE

evidence regarding the endogenous and exogenous control of attention in tasks in which subjects search for a particular 'basic' feature (e.g., search for a unique color, shape, brightness). The present review suggests that selectivity in these type of search tasks is dependent on the relative saliency of the stimulus attributes. It is concluded that the visual system automatically calculates differences in basic features (e.g., difference in shape, color, brightness) and that visual information occupying the position of the highest saliency across stimulus dimensions is exogenously passed on to the 'central representation' that is responsible for further stimulus analysis. Alternative explanations of the present findings and tentative speculations resulting from the present approach are discussed. DTIC

**N94-25909** Selskapet for Industriell og Teknisk Forskning, Trondheim (Norway).

### **ECARHEART2 VERSION 1.0: PROGRAMMERS DOCUMENTATION**

S. STOEREN and P. NEKSAE 1 Jul. 1993 44 p (PB94-124633; STF23-A93028) Avail: Issuing Activity (National Technical Information Service (NTIS))

EcarHeart2 is a program for analysis of the cardiac function and the systematic and pulmonary arterial tree. It is an EchoDisp Custom Analysis Routine (ECAR) and runs under EchoDisp. This documentation is the programmers documentation of the EcarHeart2 code. It covers the core of EcarHeart2 and the calculation modules: Aortic pressure and flow; Wall stress; and Proximal inflow convergence. NTIS

**N94-25943#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

### **THE AFIT MULTIELECTRODE ARRAY FOR NEURAL RECORDING AND SIMULATION: DESIGN, TESTING, AND ENCAPSULATION M.S. Thesis**

JAMES R. REID, JR. Dec. 1993 105 p (AD-A274086; AFIT/GE/ENG/93D-33) Avail: CASI HC A06/MF A02

A two-dimensional, X-Y addressable, multiplexed array of 256 electrodes (16 x 16) has been fabricated using conventional semiconductor processing techniques. The individual electrodes are 160 microns x 160 microns approximating the size of the cortical columns; the overall array size is 3910 microns x 3910 microns. The array has been fitted to a chronically implantable package and tested for several days in a simulated neural environment. EEG-like data were collected successfully from individual electrodes in the array. This array improves on a previous design of a 16 electrode (4 x 4) array that was chronically implanted on the cortex of a laboratory beagle (Canis familiaris) in 1982. The original implant, located approximately over primary visual cortex, recorded both EEG and visually evoked response (VER) data. It proved the feasibility of multiplexing data directly from the surface of the cortex, thereby opening the possibility of very large arrays of electrodes since only a single wideband signal channel could address significant numbers of electrodes. DTIC

**N94-26173#** Naval Health Research Center, San Diego, CA.

### **REWARMING METHODOLOGIES IN THE FIELD**

S. FEITH, R. HESSLINK, J. READING, P. KINCAID, and R. POZOS 17 Nov. 1993 20 p (Contract NR PROJ. M00-96) (AD-A274744; NHRC-93-4) Avail: CASI HC A03/MF A01

The Heatpac is currently used by the U.S. Marine Corps to warm cold-stressed infantry personnel in the field. Recently, this system has been modified so a small wetting chamber called Humipac can be attached to the Heatpac so personnel can breathe warm humidified air. The air is saturated to 95-99% humidity with a temperature range of 45.3 to 49.4 C. In a series of experiments using a USMC issue sleeping bag, the effectiveness of the Heatpac was compared to the combined Heatpac/Humipac and to rewarming by shivering. Subjects wearing only swimming trunks were placed in 12.8 C water for one hour. At the end of that period, any of the three interventions were randomly assigned. In all conditions, the subject was placed in a sleeping bag. Heart

rate, T(sub re) and T(sub es) temperatures, and metabolic rates were monitored during the cooling phase and for 120 minutes during the rewarming phase. Breathing the warm humidified air did not significantly alter the rate of body rewarming. In some cases, normal shivering induced as large an increase in core temperature as did the active interventions. Additional studies are underway to investigate the relative role that these various rewarming systems have on thermogenesis. DTIC

**N94-26179#** Naval Aerospace Medical Research Lab., Pensacola, FL.

### **EFFECTS OF METHAMPHETAMINE ON VIGILANCE AND TRACKING DURING EXTENDED WAKEFULNESS Interim Report**

R. R. STANNY, A. H. MCCARDIE, and D. F. NERI Sep. 1993 36 p

(Contract NR PROJ. M00-96)

(AD-A274896; NAMRL-1386) Avail: CASI HC A03/MF A01

The effects of a 10 mg/70 kg oral dose of d-methamphetamine HCl on high-event-rate vigilance and tracking performance in a 13.5-hour sustained-performance session during a night of sleep loss are examined. At 0116 hours, seven subjects were administered d-methamphetamine, double-blind. The remaining six subjects were given a placebo. Values of sensitivity (d) in the vigilance task declined markedly during the night in the placebo group. The methamphetamine treatment reversed an initial decline in d' within approximately two hours of administration. The methamphetamine treatment also reversed increases in nonresponses (lapses) within approximately two hours of administration. Tracking performance also declined markedly during the night in the placebo group. The methamphetamine treatment reversed the decline in tracking performance. An analysis of fast guesses in the vigilance experiment disclosed no evidence to suggest that methamphetamine tended to increase impulsive responding. In fact, the methamphetamine treatment was associated with a small and nonsignificant reduction in fast guesses. The overall pattern of the results suggests that methamphetamine at 10 mg/70 kg produces genuine increases in efficiency that effectively counteract the effects of continuous work during a night of sleep loss. DTIC

## 53

## BEHAVIORAL SCIENCES

Includes psychological factors; individual and group behavior; crew training and evaluation; and psychiatric research.

**N94-23933\*#** Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).

### **OPERATIONAL TRAINING FOR THE MISSION OPERATIONS AT THE BRAZILIAN NATIONAL INSTITUTE FOR SPACE RESEARCH (INPE)**

PAWEL ROZENFELD In JPL, SpaceOps 1992: Proceedings of the Second International Symposium on Ground Data Systems for Space Mission Operations p 667-671 1 Mar. 1993 Avail: CASI HC A01/MF A10

This paper describes the selection and training process of satellite controllers and data network operators performed at INPE's Satellite Tracking and Control Center in order to prepare them for the mission operations of the INPE's first (SCD1) satellite. An overview of the ground control system and SCD1 architecture and mission is given. Different training phases are described, taking into account that the applicants had no previous knowledge of space operations requiring, therefore, a training which started from the basics. Author (revised)

**N94-23934\*#** Jet Propulsion Lab., California Inst. of Tech., Pasadena.

### **TRAINING: PLUGGING THE INFORMATION GAPS**

CAROL J. SCOTT *In its* SpaceOps 1992: Proceedings of the Second International Symposium on Ground Data Systems for Space Mission Operations p 673-677 1 Mar. 1993  
 Avail: CASI HC A01/MF A10

Training is commonly viewed as an add-on function to the development cycle. It is imperative that this view be changed. The training developer needs to be a colleague in the system development process, contributing and learning along with the other development participants. Training developers can make contributions to design concepts that favor end-users. Early involvement will enhance the likelihood of training availability concurrent with software delivery. End-users will benefit and cost-savings will be realized. Author (revised)

**N94-23979#** Pennsylvania State Univ., University Park. Dept. of Psychology.

**PERCEPTION IN FLIGHT: SHAPE AND MOTION PERCEPTION, SPACE PERCEPTION, SPATIAL ORIENTATION, AND VISUAL VESTIBULAR INTERACTION**

HERSCHEL W. LEIBOWITZ *In* AGARD, Visual Problems in Night Operations 9 p May 1992

Copyright Avail: CASI HC A02/MF A01

Differences between the normal terrestrial and the flight environment are described which may lead to perceptual errors in flight. Specific examples involving the perception of shape and height are discussed as they may relate to nighttime landing accidents. The possible role of misperceived risk is suggested as a contributing factor. The mechanisms subserving motion perception and gaze stability are outlined briefly as the basis for understanding false sensations, illusory motion, spatial disorientation, and motion sickness. It is suggested that an appropriate countermeasure to perceptual errors in the nighttime flight environment is to inform flight crews of the mechanisms and mode of operation of the perceptual systems involved as the basis for understanding how they might malfunction.

Derived from text

**N94-23980#** Centre d'Enseignement et de Recherches de Medecine Aeronautique, Paris (France). Dept. Ergonomie Aeronautique.

**MENTAL IMAGES (LES IMAGES MENTALES)**

RENE AMALBERTI *In* AGARD, Visual Problems in Night Operations 10 p May 1992 *In* FRENCH

Copyright Avail: CASI HC A02/MF A01

The concept of mental images is paradoxically poorly linked to visual perception. It is related to the domain of mental representation, and thus is explained with reference to the field of cognitive psychology. This domain being relatively new for most of the listeners of this short course, basic concepts are didactically introduced. A framework model of cognitive activities is set up, introducing first the various memories, then focusing on mental representation processes. The specificities of mental representation are detailed (laconism, distortion, parcimony, and task-oriented). Special emphasis is given to the mental representation theory of double coding: verbal and image coding and its relationship with activity. A last section describes how mental representation, especially mental image, could serve or impair night-flight activities. Author (revised)

**N94-24266** Israel Aircraft Industries Ltd., Tashan.

**PILOT EVALUATION SYSTEM**

Y. SHUB *In* Israel Society of Aeronautics and Astronautics, The 33rd Israel Annual Conference on Aviation and Astronautics p 287-296 25 Feb. 1993

Copyright Avail: Issuing Activity (Israel Society of Aeronautics and Astronautics, c/o Faculty of Engineering, Tel-Aviv Univ., Ramat Aviv 69978, Israel)

The Pilot Evaluation System (PES) is a fixed-based, self-contained and autonomous system, designed for the screening of candidates for pilot training and the evaluation of candidates' chances for success as operational pilots. The PES evaluates and analyzes the performance of the candidate in simulated flight-like conditions. The skills evaluated by the PES are correlated

with those needed for the successful completion of flight training. The PES was designed and developed at Israel Aircraft Industries (IAI)-TASHAN by a group of experts consisting of senior fighter pilots, psychologists, physicians, engineers, and flight instructors. The measurement of performance under intense workload serves as a basis for the prediction of future pilots' abilities. In the PES, workload is defined as the combination of loads imposed on subjects by a combination of tasks in a given environment. Some air forces have acquired a PES version for their own use, and they are presently validating its performance. As the data are clients' property, they cannot be presented in this paper. ISA

**N94-24438\*#** Alabama Univ., Huntsville. Dept. of Industrial Engineering.

**EVALUATION OF COMPUTER-AIDED INSTRUCTION TECHNIQUES FOR THE CREW INTERFACE COORDINATION POSITION**

GARY P. MOYNIHAN *In its* The 1993 NASA/ASEE Summer Faculty Fellowship Program 5 p Nov. 1993

Avail: CASI HC A01/MF A03

The Crew Interface Coordinator (CIC) is responsible for real-time voice and procedural communication between the payload crew on the orbiter and the payload operations team on the ground. This function is dedicated to science activities and operations, and may also include some responsibilities for crew training. CIC training at Marshall Space Flight Center (MSFC) consists of mission-independent training, mission simulations, and line-organization training. As identified by Schneider, the program provides very good generic training; however position-specific training may be obtained in a very unstructured way. A computer-based training system, identified as Mac CIC, is currently under development to address this issue. Mac CIC is intended to provide an intermediate level of training in order to prepare the CIC for the more intensive mission simulations. Although originally intended as an intelligent tutoring system, Mac CIC currently exists as a hypertext-based application. The objectives of this research is to evaluate the current system and to provide both recommendations and a detailed plan for Mac CIC's evolution into an intelligent tutoring system. Derived from text

**N94-24467** Toronto Univ. (Ontario). Dept. of Electrical Engineering.

**PREDICTIVE HEAD MOVEMENT TRACKING USING INNOVATIONS GENERATED BY KALMAN FILTERS M.S.**

**Thesis**

ANDREW MUWANGA KIRULUTA 1993 124 p (ISBN-0-315-83371-8; CTN-94-60957) Copyright Avail: Micromedia Ltd., Technical Information Centre, 240 Catherine Street, Suite 305, Ottawa, Ontario, K2P 2G8, Canada HC/MF

The use of head movements for control leaves hands free for other tasks and utilizes the mobility of the head to acquire and track targets over a wide field of view. Kalman filtering was applied to generate prediction estimates for tracking head positions. For relatively slow smooth head movements, a constant velocity model (CVM) sufficiently represents head dynamics. However, when the head undergoes significant maneuvers, a constant acceleration model (CAM) is preferred. To take advantage of the prediction performance of the CVM under relatively slow smooth dynamics and those of the CAM under fast dynamics, a simple adaptive algorithm is proposed. Using the adaptive model yields a compromise performance for both relatively slow and fast smooth head movements. For abrupt head movements, all the above models were inadequate. An input estimation algorithm was implemented but its prediction performance degrades significantly for head accelerations in excess of 5,000 deg/sec. To provide for a baseline comparison for tracking performance, a simple parabolic polynomial fit generated prediction estimates. The resulting fit yielded prediction root mean square errors of over 2 and 23 deg for smooth and abrupt head movements respectively. Hence, the Kalman filter does indeed yield better estimates of head positions than a simple polynomial predictor. Author (CISTI)



## 53 BEHAVIORAL SCIENCES

**N94-24799\*#** Pennsylvania State Univ., University Park. Behavioral Psychophysiology Lab.

### **EEG AND CHAOS: DESCRIPTION OF UNDERLYING DYNAMICS AND ITS RELATION TO DISSOCIATIVE STATES**

#### **Final Progress Report**

WILLIAM J. RAY 23 Feb. 1994 10 p

(Contract NAG1-1441)

(NASA-CR-195171; NAS 1.26:195171) Avail: CASI HC A02/MF A01

The goal of this work is the identification of states especially as related to the process of error production and lapses of awareness as might be experienced during aviation. Given the need for further articulation of the characteristics of 'error prone state' or 'hazardous state of awareness,' this NASA grant focused on basic ground work for the study of the psychophysiology of these states. In specific, the purpose of this grant was to establish the necessary methodology for addressing three broad questions. The first is how the error prone state should be conceptualized, and whether it is similar to a dissociative state, a hypnotic state, or absent mindedness. Over 1200 subjects completed a variety of psychometric measures reflecting internal states and proneness to mental lapses and absent mindedness; the study suggests that there exists a consistency of patterns displayed by individuals who self-report dissociative experiences such that those individuals who score high on measures of dissociation also score high on measures of absent mindedness, errors, and absorption, but not on scales of hypnotizability. The second broad question is whether some individuals are more prone to enter these states than others. A study of 14 young adults who scored either high or low on the dissociation experiences scale performed a series of six tasks. This study suggests that high and low dissociative individuals arrive at the experiment in similar electrocortical states and perform cognitive tasks (e.g., mental math) in a similar manner; it is in the processing of internal emotional states that differences begin to emerge. The third question to be answered is whether recent research in nonlinear dynamics, i.e., chaos, offer an addition and/or alternative to traditional signal processing methods, i.e., fast Fourier transforms, and whether chaos procedures can be modified to offer additional information useful in identifying brain states. A preliminary review suggests that current nonlinear dynamical techniques such as dimensional analysis can be successfully applied to electrocortical activity. Using the data set developed in the study of the young adults, chaos analyses using the Farmer algorithm were performed; it is concluded that dimensionality measures reflect information not contained in traditional EEG Fourier analysis.

CASI

**N94-24855\*#** National Aeronautics and Space Administration, Washington, DC.

### **A WHITE PAPER: NASA VIRTUAL ENVIRONMENT RESEARCH, APPLICATIONS, AND TECHNOLOGY**

CYNTHIA H. NULL, ed. (National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.) and JAMES P. JENKINS, ed. 1 Oct. 1993 127 p  
(NASA-TM-109682; NAS 1.15:109682) Avail: CASI HC A07/MF A02

Research support for Virtual Environment technology development has been a part of NASA's human factors research program since 1985. Under the auspices of the Office of Aeronautics and Space Technology (OAST), initial funding was provided to the Aerospace Human Factors Research Division, Ames Research Center, which resulted in the origination of this technology. Since 1985, other Centers have begun using and developing this technology. At each research and space flight center, NASA missions have been major drivers of the technology. This White Paper was the joint effort of all the Centers which have been involved in the development of technology and its applications to their unique missions. Appendix A is the list of those who have worked to prepare the document, directed by Dr. Cynthia H. Null, Ames Research Center, and Dr. James P. Jenkins, NASA Headquarters. This White Paper describes the technology and its applications in NASA Centers (Chapters 1, 2 and 3), the potential roles it can take in NASA (Chapters 4 and 5), and a

roadmap of the next 5 years (FY 1994-1998). The audience for this White Paper consists of managers, engineers, scientists and the general public with an interest in Virtual Environment technology. Those who read the paper will determine whether this roadmap, or others, are to be followed.

Author

**N94-25298** Technische Univ., Eindhoven (Netherlands).

### **LUMINANCE-BRIGHTNESS MAPPING: THE MISSING DECADES Ph.D. Thesis**

GERARD SCHOUTEN 1993 129 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(ETN-94-95351) Avail: CASI HC A07

A study directed at the understanding of brightness perception in relation to the information reduction involved is reported. Concentration is on brightness representations of images that can be considered as single, nonrelated entities. Particularly, it is investigated whether differences between the luminance map and the brightness map may be interpreted as appearances of compression mechanisms. First of all psychophysical experiments were conducted. Some general comments concerned with the experiments can be made. Stimuli consisting of a Ganzfeld, a homogeneous field of view, on which a number of disks were superimposed, were used. The whole visual field was thus stimulated in a controllable manner. The method employed was brightness matching. More specifically, to investigate the luminance-brightness compression, the large luminance range was traversed in two different ways. In a first experiment exploring brightness constancy, scene luminances were varied with certain multipliers. In the second series of experiments, luminance ratios within a scene were altered. Subsequently, the compression mechanisms revealed by the experimental results are integrated into a novel brightness algorithm which is presented. This algorithm is applied to a set of brightness illusions including brightness induction and brightness assimilation phenomena, Mach bands, and Craik-O'Brien-Cornsweet effects.

ESA

**N94-25351\*#** Mount Holyoke Coll., South Hadley, MA. Dept. of Biological Sciences.

### **THE ROLE OF VISUAL CONTEXT IN MANUAL TARGET LOCALIZATION**

SUSAN R. BARRY /in NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 1 14 p Dec. 1993

Avail: CASI HC A03/MF A03

During space flight and immediately after return to the 1-g environment of earth, astronauts experience perceptual and sensory-motor disturbances. These changes result from adaptation of the astronaut to the microgravity environment of space. During space flight, sensory information from the eyes, limbs, and vestibular organs is reinterpreted by the central nervous system in order to produce appropriate body movements in the microgravity. This adaptation takes several days to develop. Upon return to earth, the changes in the sensory-motor system are no longer appropriate to a 1-g environment. Over several days, the astronaut must re-adapt to the terrestrial environment. Alterations in sensory-motor function may affect eye-head-hand coordination and, thus, the crewmember's ability to manually locate objects in extrapersonal space. Previous reports have demonstrated that crewmembers have difficulty in estimating joint and limb position and in pointing to memorized target positions on orbit and immediately postflight. The ability to point at or reach toward an object or perform other manual tasks is essential for safe Shuttle operation and may be compromised particularly during re-entry and landing sequences and during possible emergency egress from the Shuttle. An understanding of eye-head-hand coordination and the changes produced during space flight is necessary to develop effective countermeasures. This summer's project formed part of the study of the sensory cues use in the manual localization of objects.

Author (revised)

**N94-25437#** Minnesota Univ., Minneapolis. Dept. of Physiology.

**MECHANISMS OF EYE-HAND COORDINATION Final Report, 1 Jul. 1992 - 30 Jun. 1993**

APOSTOLOS P. GEORGOPOULOS 29 Nov. 1993 8 p

(Contract N00014-92-J-1905)

(AD-A273687) Avail: CASI HC A02/MF A01

We studied the capacities of human subjects to localize tactile stimuli in three dimensional space. For that purpose, five subjects (three women and two men) were asked to make a pointing movement to a visual stimulus in otherwise complete darkness. At some random time before, during or after this initial movement, a tactile probe was presented to the tip of the subject's index finger. The probe (1-mm diameter, 0.75-mm extent, 5-ms duration) was applied by a lightweight (80 g) tactile stimulator worn on the subject's hand. To complete the task, the subject was required to point to the three dimensional spatial location at which the probe was applied. Hand position was monitored (200 Hz) by a video-based motion analysis system. In each subject, probes presented just before or during the initial movement were systematically mislocalized in the direction of that movement so that subjects perceived the probe to be at the location occupied by the hand 50 to 100 ms after probe onset. This mislocalization is likely to be important in dealing with objects in the dark, especially with obstacles encountered along a movement's path. DTIC

**N94-25442#** Federal Aviation Administration, Oklahoma City, OK. Civil Aeromedical Inst.

**PERCEPTIONS OF ORGANIZATIONAL SUPPORT AND AFFECTIVITY AS PREDICTORS OF JOB SATISFACTION Final Report**

L. ALAN WITT Feb. 1994 13 p

(DOT/FAA/AM-94/2) Avail: CASI HC A03/MF A01

Staw, Bell, and Clausen have suggested that employees 'bring a positive or negative disposition to the work setting, process information about the job in a way that is consistent with that disposition, and then experience job satisfaction or dissatisfaction as a result.' Although this is not a universally held viewpoint, given such endeavors as the FAA Job Satisfaction Survey and managerial efforts to improve overall job satisfaction, the issue of employee disposition is important. Agency attempts to alter the work situation for the purposes of increasing job satisfaction could have limited potential for success to the extent that job satisfaction is a function of disposition. Several hypotheses examining both the main and interactive effects on job satisfaction of variables assessing the person (disposition) and situation (organizational climate) across several organizations were tested. Disposition refers to employee descriptions of how they generally feel in response to the PANAS Affectivity scale developed by Watson and Clark. The PANAS is comprised of 20 adjectives that describe both positive (PA) and negative (NA) affect. Data were accumulated by meta-analysis from 1,491 employees in 35 different organizational systems. This included survey data from employees at the FAA Aeronautical Center (N=1,029) in Oklahoma City, Air Traffic Control Specialist trainees from the FAA Academy Nonradar Screen Program (N=397) in Oklahoma City, and teachers from a rural public school system (N=65) in Illinois. Employees in each of those groups were participants in larger surveys of job satisfaction and other attitudinal factors that influence job satisfaction. Results indicated that perceptions of organizational support were more strongly related to job satisfaction than was disposition (positive affectivity (PA) or negative affectivity (NA)). NA had a larger moderating effect than PA on the perceived support-job satisfaction relationship. These results suggest that NA may have influenced the extent to which perceptions of organizational support impact employee job satisfaction. Considered together with longitudinal studies in this area, these findings suggest that dispositional differences in affectivity should be considered in interventions designed to have an impact on the attitudes of agency employees. Organizational development specialists and managers should give some consideration to how individual differences in affectivity can influence responses to the existing organizational climate and

culture as attempts are made to promote organizational change and improve overall job satisfaction. Author (revised)

**N94-25492\*#** Honeywell, Inc., Minneapolis, MN. Systems and Research Center.

**SYNTHETIC VISION SYSTEM FLIGHT TEST RESULTS AND LESSONS LEARNED**

JEFFREY RADKE In NASA. Ames Research Center, Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 29-45 Dec. 1993

Avail: CASI HC A03/MF A04

Honeywell Systems and Research Center developed and demonstrated an active 35 GHz Radar Imaging system as part of the FAA/USAF/Industry sponsored Synthetic Vision System Technology Demonstration (SVSTD) Program. The objectives of this presentation are to provide a general overview of flight test results, a system level perspective that encompasses the efforts of the SVSTD and Augmented Visual Display (AVID) programs, and more importantly, provide the AVID workshop participants with Honeywell's perspective on the lessons that were learned from the SVS flight tests. One objective of the SVSTD program was to explore several known system issues concerning radar imaging technology. The program ultimately resolved some of these issues, left others open, and in fact created several new concerns. In some instances, the interested community has drawn improper conclusions from the program by globally attributing implementation specific issues to radar imaging technology in general. The motivation for this presentation is therefore to provide AVID researchers with a better understanding of the issues that truly remain open, and to identify the perceived issues that are either resolved or were specific to Honeywell's implementation. Author

**N94-25774#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Engineering.

**DEVELOPING REALISTIC COOPERATIVE BEHAVIORS FOR AUTONOMOUS AGENTS IN AIR COMBAT SIMULATION M.S. Thesis**

DEAN P. HIPWELL Dec. 1993 169 p

(AD-A274077; AFIT/GCE/ENG/93D-05) Avail: CASI HC A08/MF A02

This thesis investigated, developed, and implemented cooperative decision-making behaviors in an air combat simulation by using a knowledge-based system. Knowledge-based systems were well suited for this task because of built-in features such as inference engines and rule-based constructs. This thesis addresses the specific problem of generating autonomous forces for inclusion in the Advanced Research Projects Agency Distributed Interactive Simulation program. Existing autonomous forces implementations lacked flexibility, realistic behaviors, real-time planning, and other features. The simulation system in this thesis addresses the problem of realistic behavior by modeling pilot decision processes rather than aircraft platforms. The system is based on phased control of a blackboard architecture. Modular knowledge bases partition rules to process decision data. Cooperative behaviors are based on a leader-follower relationship. Agents share the workload in assessing threats. Leaders make the initial decision, but followers react independently if necessary. The simulator described in this thesis provides an architecture and design for modeling combat pilot decision processes. The system was developed using the C Language Integrated Production System Object Oriented Language. DTIC

**N94-25897#** Air Force Inst. of Tech., Wright-Patterson AFB, OH. School of Logistics and Acquisition Management.

**A TEST OF THE THEORY OF REASONED ACTION AT THE GROUP LEVEL OF ANALYSIS M.S. Thesis**

THOMAS A. FITCH and EDWARD A. MCCARTY Sep. 1993 52 p

(AD-A273965; AFIT/GLM/LAR/93S-16) Avail: CASI HC A04/MF A01

A vast array of studies exist which have sought to explore the relationships between behavioral intentions, job satisfaction, turnover and performance at the individual level of analysis. Recent

## 53 BEHAVIORAL SCIENCES

efforts to move to the group level of analysis have shown some promise, but few exist. The crux of the issue under consideration here was whether or not there was utility in treating attitude-intention-behavior linkages as group level phenomena. Both Schneider (1987) and George (1990) contend that, while individual analysis cannot be discounted as a means of understanding behavior, there is also value in examining group-level phenomena. The purpose of this study was to test the generalizability of Fishbein and Ajzen's (1975) model to the group level of analysis by assessing the pattern of relationships among attitudinal, intentional, and behavioral variables. The objective of the project was to determine whether or not the basic assumptions of the theory held at the group level of analysis. DTIC

**N94-25965** Ohio State Univ., Columbus. Dept. of Psychology.  
**PACING VISUAL ATTENTION: TEMPORAL STRUCTURE EFFECTS** Ph.D. Thesis

JUNE J. SKELLY Jun. 1993 194 p Limited Reproducibility: More than 20% of this document may be affected by microfiche quality

(Contract AF PROJ. 7184)

(AD-A273859; AL-TR-1993-0024) Avail: CASI HC A09

The role of temporal relationships in how we attend to dynamic visual events was investigated. Specifically, those factors that are temporal in nature, i.e., the rate and rhythm of event sequences, were the primary variables of interest. The research explored the possibility that persisting temporal relationships may be an important factor in the external (exogenous) control of visual attention, at least to some extent, was the focus of the current research. Five experiments attempted to identify the respective roles of rate and rhythm time parameters in a simple selective attention task involving two differently timed streams of information. Results from these experiments indicated that the rhythmic structure of integrated streams was a more powerful 'pacing' factor than either of the rhythm or rate of single stream. Together, these experiments suggest that there may be two kinds of temporal 'pacing' in visual attention: (1) a passive entrainment with external time patterns, and (2) the active 'use' of timing relationships to shift and direct the focus of attention. DTIC

## 54

### MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Includes human engineering; biotechnology; and space suits and protective clothing.

**N94-23929\*** Honeywell, Inc., Minneapolis, MN. Sensor and Systems Development Center.

**INTELLIGENT TUTORING AND AIDING IN SATELLITE GROUND CONTROL** Ph.D. Thesis - Georgia Inst. of Tech., 1991

ROSE W. CHU and CHRISTINE M. MITCHELL (Georgia Inst. of Tech., Atlanta.) In JPL, SpaceOps 1992: Proceedings of the Second International Symposium on Ground Data Systems for Space Mission Operations p 645-650 1 Mar. 1993

(Contract NAS5-28575)

Avail: CASI HC A02/MF A10

In supervisory control systems such as satellite ground control, there is a need for human-centered automation where the focus is to understand and enhance the human-system interaction experience in the complex task environment. Operator support in the form of off-line intelligent tutoring and on-line intelligent aiding is one approach towards this effort. The tutor/aid paradigm is proposed here as a design approach that integrates the two aspects of operator support in one system for technically oriented adults in complex domains. This paper also presents GT-VITA, a proof-of-concept graphical, interactive, intelligent tutoring system that is a first attempt to illustrate the tutoring aspect of the tutor/aid

paradigm in the domain of satellite ground control. Evaluation on GT-VITA is conducted with NASA personnel with very positive results. GT-VITA is presented being fielded as it is at Goddard Space Flight Center. Author (revised)

**N94-23936\*** National Aeronautics and Space Administration. Goddard Space Flight Center, Greenbelt, MD.

**AUTOMATING A HUMAN FACTORS EVALUATION OF GRAPHICAL USER INTERFACES FOR NASA APPLICATIONS: AN UPDATE ON CHIMES**

JIAN-PING JIANG (Computer Technology Associates, Inc., Rockville, MD.), ELIZABETH D. MURPHY (Computer Technology Associates, Inc., Rockville, MD.), SIDNEY C. BAILIN (Computer Technology Associates, Inc., Rockville, MD.), and WALTER F. TRUSZKOWSKI In JPL, SpaceOps 1992: Proceedings of the Second International Symposium on Ground Data Systems for Space Mission Operations p 685-690 1 Mar. 1993 Sponsored in part by NASA, Washington (Contract NAS5-30680)

Avail: CASI HC A02/MF A10

Capturing human factors knowledge about the design of graphical user interfaces (GUI's) and applying this knowledge on-line are the primary objectives of the Computer-Human Interaction Models (CHIMES) project. The current CHIMES prototype is designed to check a GUI's compliance with industry-standard guidelines, general human factors guidelines, and human factors recommendations on color usage. Following the evaluation, CHIMES presents human factors feedback and advice to the GUI designer. The paper describes the approach to modeling human factors guidelines, the system architecture, a new method developed to convert quantitative RGB primaries into qualitative color representations, and the potential for integrating CHIMES with user interface management systems (UIMS). Both the conceptual approach and its implementation are discussed. This paper updates the presentation on CHIMES at the first International Symposium on Ground Data Systems for Spacecraft Control.

Author (revised)

**N94-23970\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**REDUCING VIDEO FRAME RATE INCREASES REMOTE OPTIMAL FOCUS TIME**

RICHARD F. HAINES (RECOM Technologies, Inc., Moffett Field, CA.) Jun. 1993 8 p

(Contract RTOP 476-14-03)

(NASA-TM-104018; A-93075; NAS 1.15:104018) Avail: CASI HC A02/MF A01

Twelve observers made best optical focus adjustments to a microscope whose high-resolution pattern was video monitored and displayed first on a National Television System Committee (NTSC) analog color monitor and second on a digitally compressed computer monitor screen at frame rates ranging (in six steps) from 1.5 to 30 frames per second (fps). This was done to determine whether reducing the frame rate affects the image focus. Reducing frame rate has been shown to be an effective and acceptable means of reducing transmission bandwidth of dynamic video imagery sent from Space Station Freedom (SSF) to ground scientists. Three responses were recorded per trial: time to complete the focus adjustment, number of changes of focus direction, and subjective rating of final image quality. It was found that: the average time to complete the focus setting increases from 4.5 sec at 30 fps to 7.9 sec at 1.5 fps (statistical probability =  $1.2 \times 10^{(exp - 7)}$ ); there is no significant difference in the number of changes in the direction of focus adjustment across these frame rates; and there is no significant change in subjectively determined final image quality across these frame rates. These data can be used to help pre-plan future remote optical-focus operations on SSF. Author (revised)

**N94-23974\*** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**EVALUATION OF VISUAL ACUITY WITH GEN 3 NIGHT VISION GOGGLES**

ARTHUR BRADLEY (Indiana Univ., Indianapolis.) and MARY K. KAISER Jan. 1994 40 p  
(NASA-TM-108792; A-93134; NAS 1.15:108792) Avail: CASI HC A03/MF A01

Using laboratory simulations, visual performance was measured at luminance and night vision imaging system (NVIS) radiance levels typically encountered in the natural nocturnal environment. Comparisons were made between visual performance with unaided vision and that observed with subjects using image intensification. An Amplified Night Vision Imaging System (ANVIS6) binocular image intensifier was used. Light levels available in the experiments (using video display technology and filters) were matched to those of reflecting objects illuminated by representative night-sky conditions (e.g., full moon, starlight). Results show that as expected, the precipitous decline in foveal acuity experienced with decreasing mesopic luminance levels is effectively shifted to much lower light levels by use of an image intensification system. The benefits of intensification are most pronounced foveally, but still observable at 20 deg eccentricity. Binocularity provides a small improvement in visual acuity under both intensified and unintensified conditions.

Author (revised)

**N94-23976#** Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France). Aerospace Medical Panel.

**VISUAL PROBLEMS IN NIGHT OPERATIONS [PROBLEMES DE VISION DANS LES OPERATIONS DE NUIT]**

May 1992 96 p In ENGLISH and FRENCH Lecture series held in Madrid, Spain, 1-2 Jun. 1992, in Soesterberg, Netherlands, 4-5 Jun. 1992, and in Brooks AFB, TX, 15-16 Jun. 1992 (AGARD-LS-187; ISBN-92-835-0676-6) Copyright Avail: CASI HC A05/MF A01

The aim of this Lecture Series is to provide the aeromedical specialist with a thorough understanding of the physiology of the visual system with particular concentration on the impact of the environment presented during night tactical air operations. Methods to preserve, protect, or enhance unaided night vision will be discussed. Information concerning visual performances with electro-optic devices derived from aeromedical research and field experiences will be detailed to provide the medical specialists, the engineers, and operational pilots with appropriate understanding of these increasingly common operational tools. This Lecture Series, sponsored by the Aerospace Medical Panel of AGARD, was implemented by the Consultant and Exchange Programme of AGARD.

**N94-23977#** Aerospace Medical Research Labs., Williams AFB, AZ. Aircrew Training Research Div.

**NIGHT OPERATIONS**

WILLIAM E. BERKLEY In AGARD, Visual Problems in Night Operations 4 p May 1992

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Strategists have long sought to exploit the night in military operations, not only to avoid detection and as a means to defeat visually or optically aimed weapons, but also to deny the enemy an opportunity to rest or resupply his troops. With the advent of practical and effective imaging devices, true night war fighting capability has at last become a reality (as demonstrated in the recent Gulf War). It is safe to assume that night military operations will receive even more emphasis in the future. Current aviation activities range from basic single pilot helicopter operations with night vision goggles (NVG's) to complex missions utilizing a mix of highly sophisticated aircraft with multiple sensors, precise navigational capabilities, and advanced weapons delivery systems.

Author (revised)

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**PHYSICAL ASPECTS OF THE VISUAL STIMULUS [ASPECTS PHYSIQUES DU STIMULUS VISUEL]**

JEAN-PIERRE MENU In AGARD, Visual Problems in Night

Operations 8 p May 1992 In FRENCH

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The various physical and psychophysical aspects of the visual stimulus are considered. It is a question of defining as precisely as possible the physical stimulation of input to the visual systems (nature of radiation, light intensities, colors, and organization in space and time). It is often difficult to dissociate the physical aspect from the psychophysical aspect. This last aspect translates the impact of the physical aspect on the socket and the treatment of information through the visual channel. It is consequently important to define as precisely as possible the operation of the retinal sensor. Mechanisms of the integration of information are described. The physical structure of the images of several systems of substitution to night vision are analyzed.

Transl. by FLS

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**MULTI-SENSORAL APPROACH TO NIGHT FLIGHT: PERCEPTIVE AND COGNITIVE LIMITATIONS [APPROCHE MULTI-SENSEURS POUR LE VOL DE NUIT: LIMITATIONS PERCEPTIVES ET COGNITIVES]**

RENE AMALBERTI In AGARD, Visual Problems in Night Operations 9 p May 1992 In FRENCH

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Night-flight activities have significantly grown to allow Forces being permanently operational. The level of performance for these activities is expected to be the same as it is in day time. Thus, visual support systems have been designed to mitigate the consequences of night-vision limitations, e.g. Electro-optical systems (radar), NVG, FLIR, and Real-time terrain image. Some of these support-systems are mixed, using several sources although they provide the pilot with only one resulting integrated image. Moreover, when the pilot continues to have a direct vision of the external world (vision through the optical system), the human vision has to be considered as another point of view to be integrated with this type of visual support system. This is typically what is termed the integrated multi-sensor and sensory approach. Humans have a special position in such conditions: first, from a perceptive point of view, although they are impaired by night-conditions, their eyes complement machine vision. Second, from a reasoning and decision making point of view, they must adapt their mental processes to this complex visual input made of a mixture of natural and artificial vision. The resulting effects of this position for perception and reasoning activities are described. The framework model of cognitive activities described in the previous course on mental images serves as a departure point. Then the following are discussed: (1) how humans solve the possible distortions between sensors and human vision; (2) how these perceptive input are integrated into mental representations; (3) the central question of confidence into visual support-systems; and (4) the related consequences for workload.

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**NIGHT VISION DEVICES AND CHARACTERISTICS**

H. LEE TASK In AGARD, Visual Problems in Night Operations 8 p May 1992

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Night vision goggles (NVG's) are widely used to enhance visual capability during night operations. NVG's are basically composed of an objective lens which focuses an image onto the photo-cathode of an image intensifier tube which in turn produces an amplified image that is viewed through an eyepiece lens. There are several versions of NVG's in use and in development. These include the AN/PVS-Five, AN/AVS-Six, PVS-Seven, Cat's Eyes, Nite-Op, Eagle Eyes, Merlin, and others. The first section of this paper provides a brief description and characterization of each of these NVG's. There are several parameters that are used to characterize the image quality and capability of NVG's. These parameters include field-of-view (FOV), resolution, spectral sensitivity, brightness gain, distortion, magnification, optical axes alignment, image rotation,

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

overlap, beamsplitter ratio, exit pupil diameter, eye relief, and others. Each of these is discussed in the second section of this paper. Author (revised)

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### **COCKPIT/NVG VISUAL INTEGRATION ISSUES**

H. LEE TASK /In AGARD, Visual Problems in Night Operations 6 p May 1992

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This paper is divided into two main sections: visual significance of night vision goggles (NVG) characteristics and cockpit/NVG integration issues. The first section deals with the relationship between the NVG characteristics discussed in the previous paper and visual capability. The second section explores several issues associated with successfully integrating the NVG with the aircraft cockpit for optimum system performance. Author (revised)

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### **NIGHT VISION GOGGLE ILLUSIONS AND VISUAL TRAINING**

WILLIAM E. BERKLEY /In AGARD, Visual Problems in Night Operations 6 p May 1992

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Night vision goggles (NVG's) possess certain specific visual characteristics related to their limited resolution, field of view and automatic gain control. In addition, the near infrared energy to which NVG's are most sensitive has somewhat different properties as compared to visible light. These factors combine to produce certain effects, limitations and illusions not ordinarily encountered with unaided vision. NVG visual training for aircrew members is conducted with didactic presentations, terrain board simulation, video tape presentations of intensified imagery, flight simulators utilizing computer generated imagery, and actual flight with NVG's. Computer based training and an interactive videodisc are under development. Derived from text

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### **PHYSIOLOGICAL PROTECTION FOR AIRCREW AT HIGH ALTITUDES: A REVIEW OF THE LITERATURE**

L. S. GOODMAN Apr. 1993 48 p

(DCIEM-93-13; CTN-94-60895) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

The greater performance characteristics of modern tactical aircraft allow flight at extreme altitudes. If oxygen breathing systems should fail or the canopy seal be broken, exposure to low levels of oxygen pressure will lead to hypoxia. Unconsciousness will occur within seconds at altitudes of 60,000 ft and up. The technology of hypoxia protection for aircrew during emergency cabin decompression is beginning to address this issue; in fact, the altitude performance of modern aircraft is limited by their 1950's generation oxygen systems. The basic physiology of hypoxia is first reviewed. The use of positive pressure breathing (PPB) for emergency hypoxia protection, sufficient to allow the pilot to maintain useful consciousness until the aircraft rapidly descends to safe altitudes, is then discussed in a historical perspective. The gas-exchange physiology and mechanisms whereby the correction or reduction of hypoxia is achieved are explained. This is followed by detailed discussion of the pulmonary and cardiovascular disruptions caused by PPB. The means for preventing these disruptions are reviewed, including G-suit inflation and thoracic counterpressure garments. More recently developed PPB garment technologies are highlighted and trends in PPB garment research and development are predicted.

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### **OPERATION FRICTION: DEVELOPMENT AND INTRODUCTION OF PERSONAL COOLING FOR CH124 SEA KING AIRCREW**

L. L. M. BOSSI, K. C. GLASS, J. FRIM, and M. J. BALLANTYNE

Jan. 1993 61 p

(DCIEM-93-06; CTN-94-60915) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

Sea King helicopters and aircrew were deployed to the Persian Gulf as part of Canadian support to the United Nations actions against Iraq in 1990. Due to the expected high temperatures and the requirement to operate in the aircrew chemical defense (CD) ensemble, personal cooling was required to maintain operational effectiveness. A system developed for cooling bomb disposal personnel was adapted for this purpose. This included not only manufacture and delivery within one week, but also design and implementation of CD ensemble and aircraft modifications. The cooling system included a shirt made of Nomex stretch fabric with plasticized tubing stitched throughout the inside; the tubing was connected to a pump and a bottle containing water and ice. Modifications included adapting the pump to run on aircraft power instead of battery supply. The development of doctrine, operational use of the cooling ensembles, and training of aircrew and support staff were accomplished on ship enroute to the Gulf. Physiological and operational evaluations of the cooling system show that the operational capability of the aircrews was significantly enhanced by the personal cooling system. Dressed in the full CD ensemble, the aircrews could function without being limited by heat stress.

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### **INVESTIGATION OF TIME AND INTENSITY EFFECTS IN OPERATOR WORKLOAD AND PERFORMANCE**

JIANQIAO LIAO and PAUL MILGRAM Jun. 1993 181 p

(CTN-94-60927) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

The concept of mental workload is examined and various factors affecting mental workload are discussed. Methods of mental workload measurement methods are evaluated and models of human information processing are reviewed. In a review of modeling of time and intensity domain aspects of mental workload, it is concluded that it is useful to model the human information processor as a capacity limited information channel. To test the proposed model, the performance of a simulated air traffic control (ATC) task was experimentally investigated, using NASA TLX scores to assess the subjects' mental workload. Ratings of overall mental workload were found to be sensitive to changes in the number of aircraft and the simulation update interval. High correlations were found among the six dimensions of NASA TLX. From the experimental data, a model of human performance was derived based on the concept of limited capacity. A preliminary network simulation was also developed independently, based on the assumption that the human operator could do only one task at a time. The simulation was found to predict subjects' performance well under low task demand conditions but not under high task demand conditions. It is believed that this simulation model can be greatly improved. Substantial bibliographies on mental workload are included.

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### **CREW INTERFACE ANALYSIS: SELECTED ARTICLES ON SPACE HUMAN FACTORS RESEARCH, 1987 - 1991**

TANDI BAGIAN, comp. Jul. 1993 137 p Sponsored by NASA. Washington Original contains color illustrations (NASA-TM-104756; S-697; NAS 1.15:104756) Avail: CASI HC A07/MF A02; 5 functional color pages

As part of the Flight Crew Support Division at NASA, the Crew Interface Analysis Section is dedicated to the study of human factors in the manned space program. It assumes a specialized role that focuses on answering operational questions pertaining to NASA's Space Shuttle and Space Station Freedom Programs. One of the section's key contributions is to provide knowledge and information about human capabilities and limitations that promote optimal spacecraft and habitat design and use to enhance crew

safety and productivity. The section provides human factors engineering for the ongoing missions as well as proposed missions that aim to put human settlements on the Moon and Mars. Research providing solutions to operational issues is the primary objective of the Crew Interface Analysis Section. The studies represent such subdisciplines as ergonomics, space habitability, man-computer interaction, and remote operator interaction.

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#### **SPACECRAFT CREW PROCEDURES FROM PAPER TO COMPUTERS**

MICHAEL ONEAL and MEERA MANAHAN /in NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 5-9 Jul. 1993 (Contract NAS9-17900)

Avail: CASI HC A01/MF A02; 5 functional color pages

Large volumes of paper are launched with each Space Shuttle Mission that contain step-by-step instructions for various activities that are to be performed by the crew during the mission. These instructions include normal operational procedures and malfunction or contingency procedures and are collectively known as the Flight Data File (FDF). An example of nominal procedures would be those used in the deployment of a satellite from the Space Shuttle; a malfunction procedure would describe actions to be taken if a specific problem developed during the deployment. A new FDF and associated system is being created for Space Station Freedom. The system will be called the Space Station Flight Data File (SFDF). NASA has determined that the SFDF will be computer-based rather than paper-based. Various aspects of the SFDF are discussed.

Derived from text

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**PROCESS AND REPRESENTATION IN GRAPHICAL DISPLAYS**  
DOUGLAS J. GILLAN (Lockheed Engineering and Sciences Co., Houston, TX.), ROBERT LEWIS (Rice Univ., Houston, TX.), and MARIANNE RUDISILL /in its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 10-16 Jul. 1993

Avail: CASI HC A02/MF A02; 5 functional color pages

Our initial model of graphic comprehension has focused on statistical graphs. Like other models of human-computer interaction, models of graphical comprehension can be used by human-computer interface designers and developers to create interfaces that present information in an efficient and usable manner. Our investigation of graph comprehension addresses two primary questions: how do people represent the information contained in a data graph?; and how do they process information from the graph? The topics of focus for graphic representation concern the features into which people decompose a graph and the representations of the graph in memory. The issue of processing can be further analyzed as two questions: what overall processing strategies do people use?; and what are the specific processing skills required?

Derived from text

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#### **DESIGNERS' MODELS OF THE HUMAN-COMPUTER INTERFACE**

DOUGLAS J. GILLAN and SARAH D. BREEDIN (Lockheed Engineering and Sciences Co., Houston, TX.) /in NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 17-26 Jul. 1993 (Contract NAS9-17900)

Avail: CASI HC A02/MF A02; 5 functional color pages

Understanding design models of the human-computer interface (HCI) may produce two types of benefits. First, interface development often requires input from two different types of experts: human factors specialists and software developers. Given the differences in their backgrounds and roles, human factors specialists and software developers may have different cognitive models of the HCI. Yet, they have to communicate about the interface as part of the design process. If they have different

models, their interactions are likely to involve a certain amount of miscommunication. Second, the design process in general is likely to be guided by designers' cognitive models of the HCI, as well as by their knowledge of the user, tasks, and system. Designers do not start with a blank slate; rather they begin with a general model of the object they are designing. The author's approach to a design model of the HCI was to have three groups make judgments of categorical similarity about the components of an interface: human factors specialists with HCI design experience, software developers with HCI design experience, and a baseline group of computer users with no experience in HCI design. The components of the user interface included both display components such as windows, text, and graphics, and user interaction concepts, such as command language, editing, and help. The judgments of the three groups were analyzed using hierarchical cluster analysis and Pathfinder. These methods indicated, respectively, how the groups categorized the concepts, and network representations of the concepts for each group. The Pathfinder analysis provides greater information about local, pairwise relations among concepts, whereas the cluster analysis shows global, categorical relations to a greater extent.

Derived from text

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#### **AUTOMATED SYSTEM FUNCTION ALLOCATION AND DISPLAY FORMAT: TASK INFORMATION PROCESSING REQUIREMENTS**

MARY P. CZERWINSKI /in NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 27-35 Jul. 1993 Sponsored by NASA. Washington

Avail: CASI HC A02/MF A02; 5 functional color pages

An important consideration when designing the interface to an intelligent system concerns function allocation between the system and the user. The display of information could be held constant, or 'fixed', leaving the user with the task of searching through all of the available information, integrating it, and classifying the data into a known system state. On the other hand, the system, based on its own intelligent diagnosis, could display only relevant information in order to reduce the user's search set. The user would still be left the task of perceiving and integrating the data and classifying it into the appropriate system state. Finally, the system could display the patterns of data. In this scenario, the task of integrating the data is carried out by the system, and the user's information processing load is reduced, leaving only the tasks of perception and classification of the patterns of data. Humans are especially adept at this form of display processing. Although others have examined the relative effectiveness of alphanumeric and graphical display formats, it is interesting to reexamine this issue together with the function allocation problem. Currently, Johnson Space Center is the test site for an intelligent Thermal Control System (TCS), TEXSYS, being tested for use with Space Station Freedom. Expert TCS engineers, as well as novices, were asked to classify several displays of TEXSYS data into various system states (including nominal and anomalous states). Three different display formats were used: fixed, subset, and graphical. The hypothesis tested was that the graphical displays would provide for fewer errors and faster classification times by both experts and novices, regardless of the kind of system state represented within the display. The subset displays were hypothesized to be the second most effective display format/function allocation condition, based on the fact that the search set is reduced in these displays. Both the subset and the graphic display conditions were hypothesized to be processed more efficiently than the fixed display conditions.

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#### **THE USE OF ANALYTICAL MODELS IN HUMAN-COMPUTER INTERFACE DESIGN**

LEO GUGERTY /in NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research,



## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

1987 - 1991 p 36-44 Jul. 1993

Avail: CASI HC A02/MF A02; 5 functional color pages

Recently, a large number of human-computer interface (HCI) researchers have investigated building analytical models of the user, which are often implemented as computer models. These models simulate the cognitive processes and task knowledge of the user in ways that allow a researcher or designer to estimate various aspects of an interface's usability, such as when user errors are likely to occur. This information can lead to design improvements. Analytical models can supplement design guidelines by providing designers rigorous ways of analyzing the information-processing requirements of specific tasks (i.e., task analysis). These models offer the potential of improving early designs and replacing some of the early phases of usability testing, thus reducing the cost of interface design. This paper describes some of the many analytical models that are currently being developed and evaluates the usefulness of analytical models for human-computer interface design. This paper will focus on computational, analytical models, such as the GOMS model, rather than less formal, verbal models, because the more exact predictions and task descriptions of computational models may be useful to designers. The paper also discusses some of the practical requirements for using analytical models in complex design organizations such as NASA. Derived from text

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### **USING COMPUTER GRAPHICS TO DESIGN SPACE STATION FREEDOM VIEWING**

BETTY S. GOLDSBERRY (Lockheed Engineering and Sciences Co., Houston, TX.), BUDDY O. LIPPERT (Lockheed Engineering and Sciences Co., Houston, TX.), SANDRA D. MCKEE (Lockheed Engineering and Sciences Co., Houston, TX.), JAMES L. LEWIS, JR., and FRANCIS E. MOUNT *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991* p 47-51 Jul. 1993

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Viewing requirements were identified early in the Space Station Freedom program for both direct viewing via windows and indirect viewing via cameras and closed-circuit television (CCTV). These requirements reside in NASA Program Definition and Requirements Document (PDRD), Section 3: Space Station Systems Requirements. Currently, analyses are addressing the feasibility of direct and indirect viewing. The goal of these analyses is to determine the optimum locations for the windows, cameras, and CCTV's in order to meet established requirements, to adequately support space station assembly, and to operate on-board equipment. PLAID, a three-dimensional computer graphics program developed at NASA JSC, was selected for use as the major tool in these analyses. PLAID provides the capability to simulate the assembly of the station as well as to examine operations as the station evolves. This program has been used successfully as a tool to analyze general viewing conditions for many Space Shuttle elements and can be used for virtually all Space Station components. Additionally, PLAID provides the ability to integrate an anthropometric scale-modeled human (representing a crew member) with interior and exterior architecture. Author (revised)

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### **A SIMULATION SYSTEM FOR SPACE STATION EXTRAVEHICULAR ACTIVITY**

JOSE A. MARMOLEJO and CHIP SHEPHERD (Lockheed Engineering and Sciences Co., Houston, TX.) *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991* p 52-58 Jul. 1993

Avail: CASI HC A02/MF A02; 5 functional color pages

America's next major step into space will be the construction of a permanently manned Space Station which is currently under development and scheduled for full operation in the mid-1990's. Most of the construction of the Space Station will be performed over several flights by suited crew members during an extravehicular activity (EVA) from the Space Shuttle. Once fully

operational, EVA's will be performed from the Space Station on a routine basis to provide, among other services, maintenance and repair operations of satellites currently in Earth orbit. Both voice recognition and helmet-mounted display technologies can improve the productivity of workers in space by potentially reducing the time, risk, and cost involved in performing EVA. NASA has recognized this potential and is currently developing a voice-controlled information system for Space Station EVA. Two bench-model helmet-mounted displays and an EVA simulation program have been developed to demonstrate the functionality and practicality of the system. Author (revised)

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### **USE OF INFRARED TELEMETRY AS PART OF A NONINTRUSIVE INFLIGHT DATA COLLECTION SYSTEM TO COLLECT HUMAN FACTORS DATA**

ANGELO MICOCCHI *In NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991* p 59-63 Jul. 1993

Avail: CASI HC A01/MF A02; 5 functional color pages

The objective of this paper is to present a methodology and rationale for development of a Nonintrusive Inflight Data Collection System (NIDCS) to collect Human Factors (HF) data during a space mission. These data will enable the research team to identify and resolve issues. This paper will present the background and history of the NIDCS, the methodology and techniques employed versus those in current use on Earth, initial results of the effort—including a brief description of the equipment, and, finally, a discussion of the scientific importance and possible future applications of this system elsewhere. The schema for the NIDCS includes a collection of three types of data: behavioral, physiological, and biomechanical. These will be collected using videotape of crew members' activities, bioelectric signal measurement, and measurement of kinematics and kinetics, respectively. This paper will focus on the second type of data, physiological activity as determined by changes in bioelectric potentials as crew members perform daily assignments. Author (revised)

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### **ILLUMINATION REQUIREMENTS FOR OPERATING A SPACE REMOTE MANIPULATOR**

GEORGE O. CHANDLEE (Lockheed Engineering and Sciences Co., Houston, TX.), RANDY L. SMITH (Lockheed Engineering and Sciences Co., Houston, TX.), and CHARLES D. WHEELWRIGHT *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991* p 68-72 Jul. 1993 (Contract NAS9-17900)

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Critical issues and requirements involved in illuminating remote manipulator operations in space help establish engineering designs for these manipulators. A remote manipulator is defined as any mechanical device that is controlled indirectly or from a distance by a human operator for the purpose of performing potentially dangerous or hazardous tasks to increase safety, reliability, and efficiency. Future space flights will rely on remote manipulators for a variety of tasks including satellite repair and servicing, structural assembly, data collection and analysis, and performance of contingency tasks. Carefully designed illumination of these manipulators will assure that these tasks will be completed efficiently and successfully. Studies concerning the influence of illumination on operation of a remote manipulator are few. Available results show that illumination can influence how successfully a human operates a remote manipulator. The intent of this study was to more fully examine this topic. Author (revised)

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### **PREVIOUS EXPERIENCE IN MANNED SPACE FLIGHT: A SURVEY OF HUMAN FACTORS LESSONS LEARNED**

GEORGE O. CHANDLEE (Lockheed Engineering and Sciences



Co., Houston, TX.) and BARBARA WOOLFORD *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 73-77 Jul. 1993  
(Contract NAS9-17900)

Avail: CASI HC A01/MF A02; 5 functional color pages

Previous experience in manned space flight programs can be used to compile a data base of human factors lessons learned for the purpose of developing aids in the future design of inhabited spacecraft. The objectives are to gather information available from relevant sources, to develop a taxonomy of human factors data, and to produce a data base that can be used in the future for those people involved in the design of manned spacecraft operations. A study is currently underway at the Johnson Space Center with the objective of compiling, classifying, and summarizing relevant human factors data bearing on the lessons learned from previous manned space flights. The research reported defines sources of data, methods for collection, and proposes a classification for human factors data that may be a model for other human factors disciplines. Author (revised)

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#### **HAND CONTROLLER COMMONALITY EVALUATION PROCESS**

MARK A. STUART (Lockheed Engineering and Sciences Co., Houston, TX.), JOHN M. BIERCHWALE (Lockheed Engineering and Sciences Co., Houston, TX.), ROBERT P. WILMINGTON (Lockheed Engineering and Sciences Co., Houston, TX.), SUSAN C. ADAM (Lockheed Engineering and Sciences Co., Houston, TX.), MANUEL F. DIAZ (Lockheed Engineering and Sciences Co., Houston, TX.), and DEAN G. JENSEN *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 79-84 Jul. 1993

Avail: CASI HC A02/MF A02; 5 functional color pages

Hand controller selection for NASA's Orbiter and Space Station Freedom is an important area of human-teleoperator interface design and evaluation. These input devices will control remotely operated systems that include large crane-like manipulators (e.g., Remote Manipulator System or RMS), smaller, more dexterous manipulators (e.g., Flight Teleoperator Servicer or FTS), and free flyers (e.g., Orbital Maneuvering Vehicle or OMV). Candidate hand controller configurations for these systems vary in many ways: shape, size, number of degrees-of-freedom (DOF), operating modes, provision of force reflection, range of movement, and 'naturalness' of use. Unresolved design implementation issues remain, including such topics as how the current Orbiter RMS rotational and translational rate hand controllers compare with the proposed Space Station Freedom hand controllers, the advantages that position hand controllers offer for these applications, and whether separate hand controller configurations are required for each application. Since previous studies contain little empirical hand controller task performance data, a controlled study is needed that tests Space Station Freedom candidate hand controllers during representative tasks. This study also needs to include anthropometric and biomechanical considerations. Author (revised)

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#### **PROGRAMMABLE DISPLAY PUSHBUTTONS ON THE SPACE STATION'S TELEROBOT CONTROL PANEL**

MARK A. STUART, RANDY L. SMITH, and ERVETTE P. MOORE *In NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 85-90 Jul. 1993

(Contract NAS9-17900)

Avail: CASI HC A02/MF A02; 5 functional color pages

The Man-Systems Telerobotics Laboratory at NASA's Johnson Space Center and supported by Lockheed, is working to ensure that the Flight Teleoperator Servicer (FTS) to be used on the Space Shuttle (Orbiter) and the Space Station has a well designed user interface from a Human Factors perspective. The FTS, which is a project led by NASA's Goddard Space Flight Center, will be a telerobot used for Space Station construction, maintenance, and

satellite repair. It will be directly controlled from workstations on the Orbiter and the Space Station and monitored from a ground workstation. The FTS will eventually evolve into a more autonomous system, but in the short-term the system will be manually operated (teleoperated) for many tasks. This emphasizes the importance of the human/teleoperator interface on this system. This phase of the FTS workstation evaluation covers a preliminary study of programmable display pushbuttons (PDP's). The PDP is constructed of a matrix of directly addressable electroluminescent (EL) pixels which can be used to form dot-matrix characters. PDP's can be used to display more than one message and to control more than one function. Since the PDP's have these features, then a single PDP may possibly replace the use of many single-function pushbuttons, rotary switches, and toggle switches, thus using less panel space. It is of interest to determine if PDP's can be used to adequately perform complex hierarchically structured task sequences. The objective of this investigation was to compare the performance of experienced and inexperienced Remote Manipulator System (RMS) operators while performing an RMS like task on simulated PDP and non-PDP computer prototypes so that guidelines governing the use of programmable display pushbuttons on the FTS workstation could be created. The functionality of the RMS on the Orbiter was used as a model for this evaluation since the functionality of the FTS at the time of this writing has not been solidified. Author (revised)

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#### **SPEECH VERSUS MANUAL CONTROL OF CAMERA FUNCTIONS DURING A TELEROBOTIC TASK**

JOHN M. BIERCHWALE, CARLOS E. SAMPAIO, MARK A. STUART, and RANDY L. SMITH *In NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 91-97 Jul. 1993

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This investigation has evaluated the voice-commanded camera control concept. For this particular task, total voice control of continuous and discrete camera functions was significantly slower than manual control. There was no significant difference between voice and manual input for several types of errors. There was not a clear trend in subjective preference of camera command input modality. Task performance, in terms of both accuracy and speed, was very similar across both levels of experience.

Derived from text

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#### **SPACE STATION FREEDOM COUPLING TASKS: AN EVALUATION OF THEIR TELEROBOTIC AND EVA COMPATIBILITY**

CARLOS E. SAMPAIO, JOHN M. BIERCHWALE, TERENCE F. FLEMING, and MARK A. STUART *In NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 98-103 Jul. 1993

(Contract NAS9-17900)

Avail: CASI HC A02/MF A02; 5 functional color pages

Of the couplings included in this study, several design components were found to be of interest. With respect to the operation of the couplings, the various concepts resulted in differing reactions from the four subjects who participated in this study. The purpose of this study was not to conceive the final coupling design. Rather, it was intended as a step along an interactive process. The newly modified coupling will be included in a series of further controlled, as well as subjective, evaluations. This part of the ongoing work in the Remote Operator Interaction Laboratory (ROIL) designed to enhance the overall interface by improving design at both the teleoperator and telerobot ends of the system.

Derived from text

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

**N94-24201\*#** Lockheed Engineering and Sciences Co., Houston, TX.

### **THE EFFECTS OF SPATIALLY DISPLACED VISUAL FEEDBACK ON REMOTE MANIPULATOR PERFORMANCE**

RANDY L. SMITH and MARK A. STUART *In* NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 104-110 Jul. 1993 (Contract NAS9-17900)

Avail: CASI HC A02/MF A02; 5 functional color pages

The results of this evaluation have important implications for the arrangement of remote manipulation worksites and the design of workstations for telerobot operations. This study clearly illustrates the deleterious effects that can accompany the performance of remote manipulator tasks when viewing conditions are less than optimal. Future evaluations should emphasize telerobot camera locations and the use of image/graphical enhancement techniques in an attempt to lessen the adverse effects of displaced visual feedback. An important finding in this evaluation is the extent to which results from previously performed direct manipulation studies can be generalized to remote manipulation studies. Even though the results obtained were very similar to those of the direct manipulation evaluations, there were differences as well. This evaluation has demonstrated that generalizations to remote manipulation applications based upon the results of direct manipulation studies are quite useful, but they should be made cautiously.

Derived from text

**N94-24202\*#** Lockheed Engineering and Sciences Co., Houston, TX.

### **SIMULATION OF THE HUMAN-TELEROBOT INTERFACE ON THE SPACE STATION**

MARK A. STUART and RANDY L. SMITH *In* NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 111-115 Jul. 1993 (Contract NAS9-17900)

Avail: CASI HC A02/MF A02; 5 functional color pages

Many issues remain unresolved concerning the components of the human-telerobot interface presented in this work. It is critical that these components be optimally designed and arranged to ensure, not only that the overall system's goals are met, but that the intended end-user has been optimally accommodated. With sufficient testing and evaluation throughout the development cycle, the selection of the components to use in the final telerobotic system can promote efficient, error-free performance. It is recommended that whole-system simulation with full-scale mockups be used to help design the human-telerobot interface. It is contended that the use of simulation can facilitate this design and evaluation process.

Derived from text

**N94-24203\*#** Lockheed Engineering and Sciences Co., Houston, TX.

### **QUANTITATIVE ASSESSMENT OF HUMAN MOTION USING VIDEO MOTION ANALYSIS**

JOHN D. PROBE *In* NASA. Johnson Space Center, Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 119-121 Jul. 1993

Avail: CASI HC A01/MF A02; 5 functional color pages

In the study of the dynamics and kinematics of the human body a wide variety of technologies has been developed. Photogrammetric techniques are well documented and are known to provide reliable positional data from recorded images. Often these techniques are used in conjunction with cinematography and videography for analysis of planar motion, and to a lesser degree three-dimensional motion. Cinematography has been the most widely used medium for movement analysis. Excessive operating costs and the lag time required for film development, coupled with recent advances in video technology, have allowed video based motion analysis systems to emerge as a cost effective method of collecting and analyzing human movement. The Anthropometric and Biomechanics Lab at Johnson Space Center utilizes the video based Ariel Performance Analysis System (APAS) to develop data on shirtsleeved and space-suited human performance in order to plan efficient on-orbit intravehicular and

extravehicular activities. APAS is a fully integrated system of hardware and software for biomechanics and the analysis of human performance and generalized motion measurement. Major components of the complete system include the video system, the AT compatible computer, and the proprietary software.

Derived from text

**N94-24204\*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

### **REACH PERFORMANCE WHILE WEARING THE SPACE SHUTTLE LAUNCH AND ENTRY SUIT DURING EXPOSURE TO LAUNCH ACCELERATIONS**

JAMES P. BAGIAN, MICHAEL C. GREENISEN, LAUREN E. SCHAFER (Lockheed Engineering and Sciences Co., Houston, TX.), JOHN D. PROBE (Lockheed Engineering and Sciences Co., Houston, TX.), and ROBERT W. KRUTZ, JR. (Krug International, Houston, TX.) *In* its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 122-125 Jul. 1993

Avail: CASI HC A01/MF A02; 5 functional color pages

Crewmen aboard the Space Shuttle are subjected to accelerations during ascent (the powered flight phase of launch) which range up to +3 G(sub x). Despite having 33 missions and nine years experience, not to mention all the time spent in development prior to the first flight, no truly quantitative reach study wearing actual crew equipment, using actual Shuttle seats and restraints has ever been done. What little information exists on reach performance while under acceleration has been derived primarily from subjective comments gathered retrospectively from Shuttle flight crews during their post mission debrief. This lack of reach performance data has resulted in uncertainty regarding emergency procedures that can realistically be performed during and actual Shuttle ascent versus what is practiced in the ground-fixed and motion-based Shuttle Simulators. With the introduction on STS-26 of the current Shuttle escape system, the question of reach performance under launch accelerations was once again raised. The escape system's requirement that each crewman wear a Launch/Entry Suit (LES), parachute harness, and parachute were all anticipated to contribute to a further degradation of reach performance during Shuttle ascent accelerations. In order to answer the reach performance question in a quantitative way, a photogrammetric method was chosen so that the actual reach values and associated envelopes could be captured. This would allow quantitative assessment of potential task performance impact and identify areas where changes to our Shuttle ascent emergency procedures might be required. Also, such a set of reach values would be valid for any similar acceleration profile using the same crew equipment. Potential Space Station applications of this data include predicting reach performance during Assured Crew Return Vehicle (ACRV) operations.

Derived from text

**N94-24205\*#** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

### **DEVELOPMENT OF BIOMECHANICAL MODELS FOR HUMAN FACTORS EVALUATIONS**

BARBARA WOOLFORD, ABHILASH PANDYA (Lockheed Engineering and Sciences Co., Houston, TX.), and JAMES MAIDA (Lockheed Engineering and Sciences Co., Houston, TX.) *In* its Crew Interface Analysis: Selected Articles on Space Human Factors Research, 1987 - 1991 p 126-131 Jul. 1993

Avail: CASI HC A02/MF A02; 5 functional color pages

Computer aided design (CAD) techniques are now well established and have become the norm in many aspects of aerospace engineering. They enable analytical studies, such as finite element analysis, to be performed to measure performance characteristics of the aircraft or spacecraft long before a physical model is built. However, because of the complexity of human performance, CAD systems for human factors are not in widespread use. The purpose of such a program would be to analyze the performance capability of a crew member given a particular environment and task. This requires the design capabilities to describe the environment's geometry and to describe the task's requirements, which may involve motion and strength. This in turn

requires extensive data on human physical performance which can be generalized to many different physical configurations. PLAID is developing into such a program. Begun at Johnson Space Center in 1977, it was started to model only the geometry of the environment. The physical appearance of a human body was generated, and the tool took on a new meaning as fit, access, and reach could be checked. Specification of fields-of-view soon followed. This allowed PLAID to be used to predict what the Space Shuttle cameras or crew could see from a given point.

Derived from text

**N94-24206\*** National Aeronautics and Space Administration. Lyndon B. Johnson Space Center, Houston, TX.

**ESTABLISHING A RELATIONSHIP BETWEEN MAXIMUM TORQUE PRODUCTION OF ISOLATED JOINTS TO SIMULATE EVA RATCHET PUSH-PULL MANEUVER: A CASE STUDY**

ABHILASH PANDYA (Lockheed Engineering and Sciences Co., Houston, TX.), JAMES MAIDA (Lockheed Engineering and Sciences Co., Houston, TX.), SCOTT HASSON (Texas Univ., Houston.), MICHAEL GREENISEN, and BARBARA WOOLFORD *In its Crew Interface Analysis: Selected Articles on Space Human Factors Research*, 1987 - 1991 p 132-135 Jul. 1993

Avail: CASI HC A01/MF A02; 5 functional color pages

As manned exploration of space continues, analytical evaluation of human strength characteristics is critical. These extraterrestrial environments will spawn issues of human performance which will impact the designs of tools, work spaces, and space vehicles. Computer modeling is an effective method of correlating human biomechanical and anthropometric data with models of space structures and human work spaces. The aim of this study is to provide biomechanical data from isolated joints to be utilized in a computer modeling system for calculating torque resulting from any upper extremity motions: in this study, the ratchet wrench push-pull operation (a typical extravehicular activity task). Established here are mathematical relationships used to calculate maximum torque production of isolated upper extremity joints. These relationships are a function of joint angle and joint velocity.

Derived from text

**N94-24292\*** National Defence Research Establishment, Umea (Sweden). NBC Defence Dept.

**TOWARDS A NEW RADIATION PROTECTION ORGANIZATION [PAA VAEG MOT EN NY RADIASKYDDSORGANISATION]**

TOR LARSSON, GUNNAR PERSSON, THOMAS ULVSAND, KAY EDVARSON (Statens Straalskyddinst., Stockholm, Sweden.), ROLF HELLMAN (Statens Straalskyddinst., Stockholm, Sweden.), AAKE PERSSON (Statens Straalskyddinst., Stockholm, Sweden.), INGELA FLINK (National Rescue Services Board, Sweden.), ENRICO LUNDIN (National Rescue Services Board, Sweden.), and LENA TISTAD (National Rescue Services Board, Sweden.) Jan. 1993 34 p In SWEDISH

(ISSN 0347-2124)

(FOA-C-40304-4.3; ETN-93-94490) Avail: CASI HC A03/MF

A01; National Defence Research Establishment, S-901 82 Umea, Sweden, HC

Work has been initiated to create a new protection organization for warning and mapping in radioactive fallout situations in Sweden. This organization should be the same in peace, crises and war and be able to deal with fallout, both from accidents in nuclear power stations and nuclear weapons explosions. The two present organizations, one for peace and one for war, will be substituted by the common organization. The first steps in this work are described. A description of the two present organizations is made and they are compared for two different fallout levels. This comparison is evaluated and some proposals are made for the local and regional organizations level. ESA

**N94-24299** Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).

**COMPUTER CONTROL OF AN ELECTRO-MECHANICAL REGULATOR FOR PROVIDING POSITIVE PRESSURE BREATHING AND AN ELECTRONIC G-VALVE FOR HUMAN +GZ RESEARCH**

M. PECARIC, F. BUICK, and J. MALOAN Jan. 1993 48 p (DCIEM-93-05; CTN-94-60912) Copyright Avail: Micromedia Ltd., Technical Information Centre, 165 Hotel de Ville, Place du Portage, Phase 2, Hull, Quebec J8X 3X2, Canada

Electronic G-valves and breathing regulators are being incorporated into some life support systems designed for aircrew protection. An electronically controlled G-valve and electromechanical breathing regulator were obtained and a prototype, computer controlled, life support system interface was developed and evaluated in the centrifuge. The interface was used to provide different schedules for G-suit inflation and positive pressure breathing during +Gz (PBG). Output pressures from both a G-valve and breathing regulator were driven by a voltage proportional to the centrifuge +Gz level. The required voltages were calculated from the pressure schedule. The schedules and performance of the G-valve and breathing regulator were also evaluated at different +Gz onset rates. G-suit pressure and PBG level accurately tracked the +Gz level. Outputs of both G-valve and breathing regulator reached maximum pressure within 0.2 seconds of reaching the peak +Gz level. The greatest tracking errors occurred during onset to peak +Gz with 3.0 +Gz/second profiles, most of the error being attributed to the slow response of the controller software. Author (CISTI)

**N94-24329\*** EXOS, Inc., Woburn, MA.

**DEVELOPMENT OF A FORCE FEEDBACK ANTHROPOMORPHIC TELEOPERATION INPUT DEVICE FOR CONTROL OF ROBOT HANDS Progress Report, 1 Oct - 31 Dec. 1993**

4 Feb. 1994 11 p

(Contract NAS8-39364)

(NASA-CR-195109; NAS 1.26:195109) Avail: CASI HC A03/MF A01

During the last period, the objectives specified in our last quarterly report were completed: integrated the thumb mechanism/actuator package simulation and VK software; tested the thumb mechanism/actuator package performance; designed the index finger and thumb actuation package; and developed concepts for the wrist mechanism. Author (revised)

**N94-24330\*** Texas Univ., Austin.

**CONCEPTUAL DESIGN OF A DEVICE TO MEASURE HAND SWELLING IN A MICRO-GRAVITY ENVIRONMENT**

CHRISTOPHER L. HYSINGER 12 Mar. 1993 19 p

(Contract NASW-4435)

(NASA-CR-195509; NAS 1.26:195509) Avail: CASI HC A03/MF A01

In the design of pressurized suits for use by astronauts in space, proper fit is an important consideration. One particularly difficult aspect of the suit design is the design of the gloves. If the gloves of the suit do not fit properly, the grip strength of the astronaut can be decreased by as much as fifty percent. These gloves are designed using an iterative process and can cost over 1.5 million dollars. Glove design is further complicated by the way the body behaves in a micro-gravity environment. In a micro-gravity setting, fluid from the lower body tends to move into the upper body. Some of this fluid collects in the hands and causes the hands to swell. Therefore, a pair of gloves that fit well on earth may not fit well when they are used in space. The conceptual design process for a device which can measure the swelling that occurs in the hands in a micro-gravity environment is described. This process involves developing a specifications list and function structure for the device and generating solution variants for each of the sub functions. The solution variants are then filtered, with the variants that violate any of the specifications being discarded. After acceptable solution variants are obtained, they are combined to form design concepts. These design concepts are evaluated against a set of criteria and the design concepts are ranked in order of preference. Through this process, the two most plausible design concepts were an ultrasonic imaging technique and a laser mapping technique. Both of these methods create a three dimensional model of the hand, from which the amount of swelling

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

can be determined. In order to determine which of the two solutions will actually work best, a further analysis will need to be performed.

Author (revised)

**N94-24331\*#** Texas Univ., Austin.

### **NASA PROJECT 1: FULL-BODY DYNAMOMETER**

LI-DAI LU 2 Jun. 1993 11 p

(Contract NASW-4435)

(NASA-CR-195507; NAS 1.26:195507) Avail: CASI HC A03/MF A01

In space, where the body does only a fraction of work it does on earth, muscle atrophy is a major concern. The bones and the muscles will begin to deteriorate after a short stay in weightlessness. Bone decalcification appears to be a major problem with extensive living in microgravity. Resistance exercise is not only essential to prevent muscle atrophy in space, it also helps to keep bone decalcification in check. For a space station, where the astronauts are expected to live for months at a time, exercise is especially important. Experts recommend about an hour and a half to two hours of exercise per day to keep the muscles in good condition in microgravity. The exercises will not only keep the astronauts in excellent physical condition, it will also make it easier for them to readjust to earth's gravity on return. The stationary bicycle and the treadmill have been the astronauts' primary sources of exercise since the 1970's. The major problem with both the stationary bicycle and the treadmill is that while they may keep the leg muscles from deteriorating in microgravity, they do little for muscles in the upper body. The National Aeronautics and Space Administration (NASA) is currently developing a full-body dynamometer (FBD), which will provide the astronauts with a full-body workout. It will also test the astronauts for muscle atrophy and rehabilitate the weakened muscle. The specification and the function structure for the FBD is presented.

Author (revised)

**N94-24447\*#** Saint John Fisher Coll., Rochester, NY. Chemistry Dept.

### **A CHEMICAL SENSOR AND BIOSENSOR BASED TOTALLY AUTOMATED WATER QUALITY MONITOR FOR EXTENDED SPACE FLIGHT: STEP 1**

ROBERT S. SMITH. In Alabama Univ., The 1993 NASA/ASEE Summer Faculty Fellowship Program 5 p Nov. 1993

Avail: CASI HC A01/MF A03

The result of a literature search to consider what technologies should be represented in a totally automated water quality monitor for extended space flight is presented. It is the result of the first summer in a three year JOVE project. The next step will be to build a test platform at the Authors' school, St. John Fisher College. This will involve undergraduates in NASA related research. The test flow injection analysis system will be used to test the detection limit of sensors and the performance of sensors in groups. Sensor companies and research groups will be encouraged to produce sensors which are not currently available and are needed for this project.

Author (revised)

**N94-24667\*#** Texas Univ., Austin. Mechanical Engineering Dept.

### **CONCEPTS AND EMBODIMENT DESIGN OF A REENTRY RECUMBENT SEATING SYSTEM FOR THE NASA SPACE SHUTTLE**

SCOTT MCMILLAN, BRENT LOOBY, CHRIS DEVANY, CHRIS CHUDEJ, and BARRY BROOKS 3 May 1993 53 p

(Contract NASW-4435)

(NASA-CR-195504; NAS 1.26:195504) Avail: CASI HC A04/MF A01

This report deals with the generation of a recumbent seating system which will be used by NASA to shuttle astronauts from the Russian space station Mir. We begin by examining the necessity for designing a special couch for the returning astronauts. Next, we discuss the operating conditions and constraints of the recumbent seating system and provide a detailed function structure. After working through the conceptual design process, we came up with ten alternative designs which are presented in the

appendices. These designs were evaluated and weighted to systematically determine the best choice for embodiment design. A detailed discussion of all components of the selected system follows with design calculations for the seat presented in the appendices. The report concludes with an evaluation of the resulting design and recommendations for further development.

Author

**N94-24706\*#** Harvard Univ., Cambridge, MA. Div. of Applied Sciences.

### **MICROBIAL BIOFILM FORMATION AND ITS CONSEQUENCES FOR THE CELSS PROGRAM Final Report**

R. MITCHELL 31 Jan. 1994 4 p

(Contract NCC2-628)

(NASA-CR-195146; NAS 1.26:195146) Avail: CASI HC A01/MF A01

A major goal of the Controlled Ecology Life Support System (CELSS) program is to provide reliable and efficient life support systems for long-duration space flights. A principal focus of the program is on the growth of higher plants in growth chambers. These crops should be grown without the risk of damage from microbial contamination. While it is unlikely that plant pathogens will pose a risk, there are serious hazards associated with microorganisms carried in the nutrient delivery systems and in the atmosphere of the growth chamber. Our experience in surface microbiology showed that colonization of surfaces with microorganisms is extremely rapid even when the inoculum is small. After initial colonization extensive biofilms accumulate on moist surfaces. These microbial films metabolize actively and slough off continuously to the air and water. During plant growth in the CELSS program, microbial biofilms have the potential to foul sensors and to plug nutrient delivery systems. In addition both metabolic products of microbial growth and degradation products of materials being considered for use as nutrient reservoirs and for delivery are likely sources of chemicals known to adversely affect plant growth.

Author (revised)

**N94-24786\*#** Texas Univ., Austin. Mechanical Engineering Dept.

### **DESIGN OF A RECUMBENT SEATING SYSTEM**

SCOTT CROYLE, JOSE DELAROSA, DAREN GEORGE, CATHY HINKLE, and STEPHEN KARAS 3 May 1993 61 p

(Contract NASW-4435)

(NASA-CR-195503; NAS 1.26:195503) Avail: CASI HC A04/MF A01

Future space shuttle missions presented by NASA might require the shuttle to rendezvous with the Russian space station Mir for the purpose of transporting astronauts back to earth. Due to the atrophied state of these astronauts, a special seating system must be designed for their transportation. The main functions of this seating system are to support and restrain the astronauts during normal reentry flight and to dampen some of the loading that might occur in a crash situation. Through research, the design team developed many concept variants for these functional requirements. By evaluating each variant, the concepts were eliminated until the four most attractive designs remained. The team used a decision matrix to determine the best concept to carry through embodiment. This concept involved using struts for support during reentry flight and a spring damper/shock absorber system to dampen crash landing loads. The embodiment design process consisted of defining the layout of each of the main functional components, specifically, the seat structure and the strut structure. Through the use of MCS/pal two, the design was refined until it could handle all required loads and dampen to the forces specified. The auxiliary function carriers were then considered. Following the design of these components, the complete final layout could be determined. It is concluded that the final design meets all specifications outlined in the conceptual design. The main advantages of this design are its low weight, simplicity, and large amount of function sharing between different components. The disassembly of this design could potentially present a problem because of time and size constraints involved. Overall, this design meets or exceeds all functional requirements.

Author (revised)

**N94-24830#** Galaxy Scientific Corp., Pleasantville, NJ.  
**PILOT-VEHICLE INTERFACE HANDBOOK, CHAPTER 19.**  
**VOLUME 2: DIGITAL SYSTEMS VALIDATION**  
 L. HARRISON, J. JANOWITZ, and M. CASTRONUOVO Nov.  
 1993 118 p  
 (Contract DTFA03-89-C-0043)  
 (DOT/FAA/CT-88/10-VOL-2) Avail: CASI HC A06/MF A02

The cockpits of the early transport aircraft were quite different from those produced today. Older cockpits contained numerous 'steam gauge' style indicators. As technology advanced, these older electromechanical indicators were gradually replaced by newer, more reliable digital systems. Digital flight control and avionics systems are being used increasingly in modern aircraft. This trend yields cockpits of greater complexity and has swelled the amount of information with which the crew must deal. The way the pilot controls and monitors the state of the aircraft has also been greatly influenced by the increased use of digital systems. Additionally, new methods of aircraft system monitoring and control are being researched and implemented. These systems use new display technology, programmable display formats, voice input and output, and other new input and control devices. Systems and their cockpit interfaces were added as technological advances were made and new requirements generated. The human interface was given little consideration in the layout of the cockpit. Human qualities and failure modes were not taken into account in the cockpit design process. As the number of systems, components, indicators, and switches multiplied, the potential for error also grew. The emphasis of this report is on civil transport aircraft. This includes technologies such as display, control, and design methodologies, along with human factors concerns. The report consists of four sections: civil transport cockpit, cockpit standards, cockpit technology, and cockpit human factors. This report is to serve as a guide to Certification Engineers who are faced with the task of certification of new cockpit technologies. Author (revised)

**N94-24835#** Texas Univ., Austin.  
**SPECIFICATION LIST AND FUNCTION STRUCTURE FOR A FULL-BODY DYNAMOMETER TO BE USED ABOARD SPACE STATION FREEDOM**  
 ROBERT MCMAHAN 19 Feb. 1993 11 p  
 (Contract NASW-4435)  
 (NASA-CR-195508; NAS 1.26:195508) Avail: CASI HC A03/MF A01

NASA has a need for a machine which can be used as an exercise device and as an instrument to measure an astronaut's muscle performance. The purpose of the exercise device is to work various muscle groups of the astronaut to prevent muscle atrophy, the loss of muscle strength and mass from prolonged exposure to a microgravity environment. The measurement part of the machine will be used to collect data on the strength and power of the astronaut's muscle groups to be used in studies examining the effects of prolonged space habitation. The principle device used in this machine to both exercise and measure muscle performance is the dynamometer. The dynamometer converts electrical energy to mechanical energy and mechanical energy to electrical energy or signals. The task of the designer will be to incorporate a dynamometer into a device which can meet all of the needs discussed above. This memorandum has two sections which clarify the design task of producing a full-body dynamometer. The first section is a specification list. The specification list provides the requirements that the designer must meet in his/her design. The second part is a function structure. The function structure shows graphically the flow of material, energy, and information through the machine. These two items will be used by the designer in the design process for the full-body dynamometer.

Derived from text

**N94-24857#** North Carolina Univ., Charlotte. Dept. of Mechanical Engineering and Engineering Science.  
**DESIGN AND SIMULATION OF EVA TOOLS FOR FIRST SERVICING MISSION OF HST Semiannual Report, 15 Jan. - 14 Jul. 1993**  
 DIPAK NAIK and P. H. DEHOFF 14 Jul. 1993 12 p

(Contract NAG5-2038)  
 (NASA-CR-194784; NAS 1.26:194784; TR-ME/ES-93-2) Avail:  
 CASI HC A03/MF A01

The Hubble Space Telescope (HST) was launched into near-earth orbit by the space shuttle Discovery on April 24, 1990. The payload of two cameras, two spectrographs, and a high-speed photometer is supplemented by three fine-guidance sensors that can be used for astronomy as well as for star tracking. A widely reported spherical aberration in the primary mirror causes HST to produce images of much lower quality than intended. A space shuttle repair mission in late 1993 will install small corrective mirrors that will restore the full intended optical capability of the HST. The first servicing mission (FSM) will involve considerable extravehicular activity (EVA). It is proposed to design special EVA tools for the FSM. This report includes details of the data acquisition system being developed to test the performance of the various EVA tools in ambient as well as simulated space environment.

Author (revised)

**N94-24956#** Texas Univ., Austin. Dept. of Mechanical Engineering.  
**CONCEPTUAL DESIGN OF AN ASTRONAUT HAND ANTHROPOMETRY DEVICE**  
 ROBERT MCMAHAN 12 Mar. 1993 18 p  
 (Contract NASW-4435)  
 (NASA-CR-195490; NAS 1.26:195490) Avail: CASI HC A03/MF A01

In a microgravity environment, fluid equalizes throughout the body, causing the upper body to swell. This causes the hands to swell which can cause problems for astronauts trying to do work in pressurized EVA (extravehicular activity) gloves. To better design these gloves, accurate measurements of the astronauts swollen hands are needed. Five concepts were developed in this report from an original field of 972 possible concepts. These five concepts were based on mold impression, ultrasound, laser topography, white light photography, and video imaging. From a decision matrix based on nine weighted criteria, the video imaging technique was found to be the best design to pursue. Author (revised)

**N94-25102#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.  
**A SIMULATION STUDY OF CONTROL AND DISPLAY REQUIREMENTS FOR ZERO-EXPERIENCE GENERAL AVIATION PILOTS**  
 ERIC C. STEWART *In its* NASA LaRC Workshop on Guidance, Navigation, Controls, and Dynamics for Atmospheric Flight, 1993 p 147-175 Dec. 1993  
 Avail: CASI HC A03/MF A04

The purpose of this simulation study was to define the basic human factor requirements for operating an airplane in all weather conditions. The basic human factors requirements are defined as those for an operator who is a complete novice for airplane operations but who is assumed to have automobile driving experience. These operators thus have had no piloting experience or training of any kind. The human factor requirements are developed for a practical task which includes all of the basic maneuvers required to go from one airport to another airport in limited visibility conditions. The task was quite demanding including following a precise path with climbing and descending turns while simultaneously changing airspeed. The ultimate goal of this research is to increase the utility of general aviation airplanes - that is, to make them a practical mode of transportation for a much larger segment of the general population. This can be accomplished by reducing the training and proficiency requirements of pilots while improving the level of safety. It is believed that advanced technologies such as fly-by-wire (or light), and head-up pictorial displays can be of much greater benefit to the general aviation pilot than to the full-time, professional pilot. Author

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

**N94-25354\*#** Nebraska Univ., Omaha. Dept. of Industrial and Management Systems Engineering.

### **INVESTIGATION OF HAND CAPABILITIES UNDER A VARIETY OF PERFORMANCE CONDITIONS AND AN ATTEMPT TO EXPLAIN PERFORMANCE DIFFERENCES**

RAM R. BISHU and LISA BRONKEMA /In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 1 14 p Dec. 1993

Avail: CASI HC A03/MF A03

Human capabilities such as dexterity, manipulability, and tactile perception are unique and render the hands as a very versatile, effective and a multipurpose tool. This is especially true for environments such as the EVA environment. However, with the use of the protective EVA gloves, there is much evidence to suggest that human performance decreases. In order to determine the nature and cause of this performance decrement, several performance tests were run which studied the effects of gloves on strength, tactile feedback, and range of motion. Tactile sensitivity was measured as a function of grip strength, and the results are discussed. Equipment which was developed to measure finger range of motion along with corresponding finger strength values is discussed. The results of these studies have useful implications for improved glove design. Author (revised)

**N94-25363\*#** Houston Univ., TX. College of Technology.

### **IMAGE REMAPPING STRATEGIES APPLIED AS PROTHESES FOR THE VISUALLY IMPAIRED**

CURTIS D. JOHNSON /In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 1 11 p Dec. 1993

Avail: CASI HC A03/MF A03

Maculopathy and retinitis pigmentosa (rp) are two vision defects which render the afflicted person with impaired ability to read and recognize visual patterns. For some time there has been interest and work on the use of image remapping techniques to provide a visual aid for individuals with these impairments. The basic concept is to remap an image according to some mathematical transformation such that the image is warped around a maculopathic defect (scotoma) or within the rp foveal region of retinal sensitivity. NASA/JSC has been pursuing this research using angle invariant transformations with testing of the resulting remapping using subjects and facilities of the University of Houston, College of Optometry. Testing is facilitated by use of a hardware device, the Programmable Remapper, to provide the remapping of video images. This report presents the results of studies of alternative remapping transformations with the objective of improving subject reading rates and pattern recognition. In particular a form of conformal transformation was developed which provides for a smooth warping of an image around a scotoma. In such a case it is shown that distortion of characters and lines of characters is minimized which should lead to enhanced character recognition. In addition studies were made of alternative transformations which, although not conformal, provide for similar low character distortion remapping. A second, non-conformal transformation was studied for remapping of images to aid rp impairments. In this case a transformation was investigated which allows remapping of a vision field into a circular area representing the foveal retina region. The size and spatial representation of the image are selectable. It is shown that parametric adjustments allow for a wide variation of how a visual field is presented to the sensitive retina. This study also presents some preliminary considerations of how a prosthetic device could be implemented in a practical sense, vis-a-vis, size, weight and portability. Author

**N94-25369\*#** Wyoming Univ., Laramie. Dept. of Computer Science.

### **AN EVALUATION OF THREE-DIMENSIONAL SENSORS FOR THE EXTRAVEHICULAR ACTIVITY HELPER/RETRIEVER**

MICHAEL MAGEE /In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society

for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 8 p Dec. 1993

Avail: CASI HC A02/MF A03

The Extravehicular Activity Retriever/Helper (EVAHR) is a robotic device currently under development at the NASA Johnson Space Center that is designed to fetch objects or to assist in retrieving an astronaut who may have become inadvertently de-tethered. The EVAHR will be required to exhibit a high degree of intelligent autonomous operation and will base much of its reasoning upon information obtained from one or more three-dimensional sensors that it will carry and control. At the highest level of visual cognition and reasoning, the EVAHR will be required to detect objects, recognize them, and estimate their spatial orientation and location. The recognition phase and estimation of spatial pose will depend on the ability of the vision system to reliably extract geometric features of the objects such as whether the surface topologies observed are planar or curved and the spatial relationships between the component surfaces. In order to achieve these tasks, accurate sensing of the operational environment and objects in the environment will therefore be critical. The qualitative and quantitative results of empirical studies of three sensors that are capable of providing three-dimensional information to the EVAHR, but using completely different hardware approaches are documented. The first of these devices is a phase shift laser with an effective operating range (ambiguity interval) of approximately 15 meters. The second sensor is a laser triangulation system designed to operate at much closer range and to provide higher resolution images. The third sensor is a dual camera stereo imaging system from which range images can also be obtained. The remainder of the report characterizes the strengths and weaknesses of each of these systems relative to quality of data extracted and how different object characteristics affect sensor operation. Author

**N94-25371\*#** Purdue Univ., West Lafayette, IN. Dept. of Agricultural Engineering.

### **ROBOTICS IN A CONTROLLED, ECOLOGICAL LIFE SUPPORT SYSTEM**

GAINES E. MILES and KIMBERLY J. KROM /In NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 27 p Dec. 1993

Avail: CASI HC A03/MF A03

Controlled, Ecological Life Support Systems (CELSS) that utilize plants to provide food, water and oxygen could consume considerable amounts of labor unless crop production, recovery and processing are automated. Robotic manipulators equipped with special end-effectors and programmed to perform the sensing and materials handling tasks would minimize the amount of astronaut labor required. The Human Rated Test Facility (HRTF) planned for Johnson Space Center could discover and demonstrate techniques of crop production which can be reliably integrated with machinery to minimize labor requirements. Before the physical components (shelves, lighting fixtures, etc.) can be selected, a systems analysis must be performed to determine which alternative processes should be followed and how the materials handling tasks should be automated. Given that the current procedures used to grow crops in a CELSS may not be the best methods to automate, then what are the alternatives? How many plants be grown, harvested, processed for food, and the inedible components recycled? What commercial technologies current exist? What research efforts are underway to develop new technologies which might satisfy the need for automation in a CELSS? The answers to these questions should prove enlightening and provide some of the information necessary to perform the systems analysis. The planting, culturing, gathering, threshing and separation, food processing, and recovery of inedible portions of wheat were studied. The basic biological and materials handling processes of each task are defined and discussed. Current practices at Johnson Space Center and other NASA centers are described and compared to common production practices in the plant production industry. Technologies currently being researched which might be applicable



are identified and illustrated. Finally, based on this knowledge, several scenarios are proposed for automating the tasks for wheat. Author

**N94-25375\*#** Bevill State Community Coll., Fayette, AL. Chemistry Dept.

**INVESTIGATING PYROLYSIS/INCINERATION AS A METHOD OF RESOURCE RECOVERY FROM SOLID WASTE**

BOBBY J. ROBERTSON and CHRISTOPHER S. LEMAY *In* NASA. Johnson Space Center, National Aeronautics and Space Administration (NASA)/American Society for Engineering Education (ASEE) Summer Faculty Fellowship Program, 1993, Volume 2 11 p Dec. 1993

Avail: CASI HC A03/MF A03

Pyrolysis/incineration (P/I) is a physicochemical method for the generation of recoverable resources from solid waste materials such as inedible plant biomass (IPB), paper, plastics, cardboard, etc. P/I permits the collection of numerous gases with a minimal amount of solid residue. Pyrolysis, also known as starved air incineration, is usually conducted at relatively high temperatures (greater than 500 deg C) in the absence of oxygen. Incineration is conducted at lower temperatures in the presence of oxygen. The primary purpose of this study was to design, construct, and test a model P/I. The system design includes safety requirements for temperature and pressure. The objectives of this study were: (1) to design and construct a P/I system for incorporation with the Hybrid Regenerative Water Recovery System; (2) to initiate testing of the P/I system; (3) to collect and analyze P/I system data; (4) to consider test variables; and (5) to determine the feasibility of P/I as an effective method of resource recovery. A P/I system for the recovery of reusable resources from solid waste materials was designed, constructed, and tested. Since a large amount of inedible plant biomass (IPB) will be generated in a space-based habitat on the lunar surface and Mars, IPB was the primary waste material tested in the system. Analysis of the effluent gases was performed to determine which gases could be used in a life support system. Author

**N94-25490\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**PROCEEDINGS OF THE WORKSHOP ON AUGMENTED VISUAL DISPLAY (AVID) RESEARCH**

MARY K. KAISER, ed. and BARBARA T. SWEET, ed. Dec. 1993 428 p Workshop held in Moffett Field, CA, 10-12 Mar. 1993

(Contract RTOP 505-64-36)

(NASA-CP-10128; A-93123; NAS 1.55:10128) Avail: CASI HC A19/MF A04

The papers, abstracts, and presentations were presented at a three day workshop focused on sensor modeling and simulation, and image enhancement, processing, and fusion. The technical sessions emphasized how sensor technology can be used to create visual imagery adequate for aircraft control and operations. Participants from industry, government, and academic laboratories contributed to panels on Sensor Systems, Sensor Modeling, Sensor Fusion, Image Processing (Computer and Human Vision), and Image Evaluation and Metrics.

**N94-25500\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**ENGINEERING WORKSTATION: SENSOR MODELING**

M PAVEL and B. SWEET *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 181-190 Dec. 1993

Avail: CASI HC A02/MF A04

The purpose of the engineering workstation is to provide an environment for rapid prototyping and evaluation of fusion and image processing algorithms. Ideally, the algorithms are designed to optimize the extraction of information that is useful to a pilot for all phases of flight operations. Successful design of effective fusion algorithms depends on the ability to characterize both the information available from the sensors and the information useful to a pilot. The workstation is comprised of subsystems for simulation

of sensor-generated images, image processing, image enhancement, and fusion algorithms. As such, the workstation can be used to implement and evaluate both short-term solutions and long-term solutions. The short-term solutions are being developed to enhance a pilot's situational awareness by providing information in addition to his direct vision. The long term solutions are aimed at the development of complete synthetic vision systems. One of the important functions of the engineering workstation is to simulate the images that would be generated by the sensors. The simulation system is designed to use the graphics modeling and rendering capabilities of various workstations manufactured by Silicon Graphics Inc. The workstation simulates various aspects of the sensor-generated images arising from phenomenology of the sensors. In addition, the workstation can be used to simulate a variety of impairments due to mechanical limitations of the sensor placement and due to the motion of the airplane. Although the simulation is currently not performed in real-time, sequences of individual frames can be processed, stored, and recorded in a video format. In that way, it is possible to examine the appearance of different dynamic sensor-generated and fused images.

Author (revised)

**N94-25501\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**IMAGE FUSION**

M. PAVEL (Western Aerospace Labs., Inc., Moffett Field, CA.) *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 193-205 Dec. 1993 (Contract NCC2-486)

Avail: CASI HC A03/MF A04

The topics covered include the following: a system overview of the basic components of a system designed to improve the ability of a pilot to fly through low-visibility conditions such as fog; the role of visual sciences; fusion issues; sensor characterization; sources of information; image processing; and image fusion.

CASI

**N94-25505\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

**MULTIPLE-CAMERA/MOTION STEREOSCOPY FOR RANGE ESTIMATION IN HELICOPTER FLIGHT**

PHILLIP N. SMITH, BANAVAR SRIDHAR, and RAYMOND E. SUORSA *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 287-291 Dec. 1993

Avail: CASI HC A01/MF A04

Aiding the pilot to improve safety and reduce pilot workload by detecting obstacles and planning obstacle-free flight paths during low-altitude helicopter flight is desirable. Computer vision techniques provide an attractive method of obstacle detection and range estimation for objects within a large field of view ahead of the helicopter. Previous research has had considerable success by using an image sequence from a single moving camera to solving this problem. The major limitations of single camera approaches are that no range information can be obtained near the instantaneous direction of motion or in the absence of motion. These limitations can be overcome through the use of multiple cameras. This paper presents a hybrid motion/stereo algorithm which allows range refinement through recursive range estimation while avoiding loss of range information in the direction of travel. A feature-based approach is used to track objects between image frames. An extended Kalman filter combines knowledge of the camera motion and measurements of a feature's image location to recursively estimate the feature's range and to predict its location in future images. Performance of the algorithm will be illustrated using an image sequence, motion information, and independent range measurements from a low-altitude helicopter flight experiment. Author (revised)

**N94-25507\*#** National Aeronautics and Space Administration. Langley Research Center, Hampton, VA.

**A MODEL-BASED APPROACH FOR DETECTION OF OBJECTS IN LOW RESOLUTION PASSIVE-MILLIMETER WAVE IMAGES**

YUAN-LIANG TANG (Pennsylvania State Univ., University Park.),



## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

SADASHIVA DEVADIGA (Pennsylvania State Univ., University Park.), RANGACHAR KASTURI (Pennsylvania State Univ., University Park.), and RANDALL L. HARRIS, SR. *In* NASA. Ames Research Center, Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 313-328 Dec. 1993 (Contract NAG1-1371)

Avail: CASI HC A03/MF A04

We describe a model-based vision system to assist pilots in landing maneuvers under restricted visibility conditions. The system was designed to analyze image sequences obtained from a Passive Millimeter Wave (PMMW) imaging system mounted on the aircraft to delineate runways/taxiways, buildings, and other objects on or near runways. PMMW sensors have good response in a foggy atmosphere; but, their spatial resolution is very low. However, additional data such as airport model and approximate position and orientation of aircraft are available. We exploit these data to guide our model-based system to locate objects in the low resolution image and generate warning signals to alert the pilots. We also derive analytical expressions for the accuracy of the camera position estimate obtained by detecting the position of known objects in the image. Author (revised)

**N94-25508\*#** Honeywell, Inc., Minneapolis, MN. Systems and Research Center.

### **IMAGE PROCESSING FOR FLIGHT CREW ENHANCED SITUATION AWARENESS**

BARRY ROBERTS *In* NASA. Ames Research Center, Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 329-360 Dec. 1993

Avail: CASI HC A03/MF A04

This presentation describes the image processing work that is being performed for the Enhanced Situational Awareness System (ESAS) application. Specifically, the presented work supports the Enhanced Vision System (EVS) component of ESAS.

Author (revised)

**N94-25510\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

### **EXTRACTING HEADING AND TEMPORAL RANGE FROM OPTIC FLOW: HUMAN PERFORMANCE ISSUES**

MARY K. KAISER, JOHN A. PERRONE, LELAND STONE, MARTIN S. BANKS (California Univ., Berkeley.), and JAMES A. CROWELL (California Univ., Berkeley.) *In* its Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 379-396 Dec. 1993

Avail: CASI HC A03/MF A04

Pilots are able to extract information about their vehicle motion and environmental structure from dynamic transformations in the out-the-window scene. In this presentation, we focus on the information in the optic flow which specifies vehicle heading and distance to objects in the environment, scaled to a temporal metric. In particular, we are concerned with modeling how the human operators extract the necessary information, and what factors impact their ability to utilize the critical information. In general, the psychophysical data suggest that the human visual system is fairly robust to degradations in the visual display, e.g., reduced contrast and resolution or restricted field of view. However, extraneous motion flow, i.e., introduced by sensor rotation, greatly compromises human performance. The implications of these models and data for enhanced/synthetic vision systems are discussed.

Author (revised)

**N94-25511\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

### **OPTICAL INFORMATION IN LANDING SCENES**

WALTER W. JOHNSON *In* its Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 397-406 Dec. 1993

Avail: CASI HC A02/MF A04

During landing, the visual scene contains optical information about speed, altitude, glide slope, and track that is useful for the maintenance of spatial orientation and awareness. This information, embedded in the structure and transformations of the optical

patterns, may be globally, regionally, or locally available. Global changes occur everywhere in the visual field during landing and include such information as flow rate acceleration due to changing speed and/or altitude. Regional changes occur within a more restricted area and include such information as horizon line motion due to aircraft pitching and rolling. Locally available changes are the most restricted and include such information as changes in runway form ratios due to changing glide slopes. Thus, within partially or fully synthetic displays, or within sensor-driven displays, preservation of flow rate and horizon motion information requires a minimum of knowledge about the details of the airport layout, while runway outlines do require much more knowledge of the layout. All may be important, however, and these, as well as other sources of optical information, can provide a pilot with his most natural framework for maintaining orientation. Author (revised)

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### **SENSOR FUSION DISPLAY EVALUATION USING INFORMATION INTEGRATION MODELS IN ENHANCED/SYNTHETIC VISION APPLICATIONS**

DAVID C. FOYLE *In* its Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 409-419 Dec. 1993

Avail: CASI HC A03/MF A04

Based on existing integration models in the psychological literature, an evaluation framework is developed to assess sensor fusion displays as might be implemented in an enhanced/synthetic vision system. The proposed evaluation framework for evaluating the operator's ability to use such systems is a normative approach: The pilot's performance with the sensor fusion image is compared to models' predictions based on the pilot's performance when viewing the original component sensor images prior to fusion. This allows for the determination as to when a sensor fusion system leads to: poorer performance than one of the original sensor displays, clearly an undesirable system in which the fused sensor system causes some distortion or interference; better performance than with either single sensor system alone, but at a sub-optimal level compared to model predictions; optimal performance compared to model predictions; or, super-optimal performance, which may occur if the operator were able to use some highly diagnostic 'emergent features' in the sensor fusion display, which were unavailable in the original sensor displays. Author (revised)

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### **QUALITY METRICS FOR SENSOR IMAGES**

AL AHUMADA *In* its Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 421-422 Dec. 1993

Avail: CASI HC A01/MF A04

Methods are needed for evaluating the quality of augmented visual displays (AVID). Computational quality metrics will help summarize, interpolate, and extrapolate the results of human performance tests with displays. The FLM Vision group at NASA Ames has been developing computational models of visual processing and using them to develop computational metrics for similar problems. For example, display modeling systems use metrics for comparing proposed displays, halftoning optimizing methods use metrics to evaluate the difference between the halftone and the original, and image compression methods minimize the predicted visibility of compression artifacts. The visual discrimination models take as input two arbitrary images A and B and compute an estimate of the probability that a human observer will report that A is different from B. If A is an image that one desires to display and B is the actual displayed image, such an estimate can be regarded as an image quality metric reflecting how well B approximates A. There are additional complexities associated with the problem of evaluating the quality of radar and IR enhanced displays for AVID tasks. One important problem is the question of whether intruding obstacles are detectable in such displays. Although the discrimination model can handle detection situations by making B the original image A plus the intrusion, this detection model makes the inappropriate assumption that the

observer knows where the intrusion will be. Effects of signal uncertainty need to be added to our models. A pilot needs to make decisions rapidly. The models need to predict not just the probability of a correct decision, but the probability of a correct decision by the time the decision needs to be made. That is, the models need to predict latency as well as accuracy. Luce and Green have generated models for auditory detection latencies. Similar models are needed for visual detection. Most image quality models are designed for static imagery. Watson has been developing a general spatial-temporal vision model to optimize video compression techniques. These models need to be adapted and calibrated for AVID applications. Derived from text

**N94-25514\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

#### **EVALUATION OF IMAGE QUALITY**

M. PAVEL (Western Aerospace Labs., Inc., Moffett Field, CA.) *In its* Proceedings of the Workshop on Augmented Visual Display (AVID) Research p 423-431 Dec. 1993  
 Avail: CASI HC A02/MF A04

This presentation outlines in viewgraph format a general approach to the evaluation of display system quality for aviation applications. This approach is based on the assumption that it is possible to develop a model of the display which captures most of the significant properties of the display. The display characteristics should include spatial and temporal resolution, intensity quantizing effects, spatial sampling, delays, etc. The model must be sufficiently well specified to permit generation of stimuli that simulate the output of the display system. The first step in the evaluation of display quality is an analysis of the tasks to be performed using the display. Thus, for example, if a display is used by a pilot during a final approach, the aesthetic aspects of the display may be less relevant than its dynamic characteristics. The opposite task requirements may apply to imaging systems used for displaying navigation charts. Thus, display quality is defined with regard to one or more tasks. Given a set of relevant tasks, there are many ways to approach display evaluation. The range of evaluation approaches includes visual inspection, rapid evaluation, part-task simulation, and full mission simulation. The work described is focused on two complementary approaches to rapid evaluation. The first approach is based on a model of the human visual system. A model of the human visual system is used to predict the performance of the selected tasks. The model-based evaluation approach permits very rapid and inexpensive evaluation of various design decisions. The second rapid evaluation approach employs specifically designed critical tests that embody many important characteristics of actual tasks. These are used in situations where a validated model is not available. These rapid evaluation tests are being implemented in a workstation environment. Author (revised)

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#### **CREATION OF PROTOTYPE AIRCREW PROTECTION**

**EQUIPMENT BASED ON FACE ANTHROPOMETRY M.S. Thesis**  
 MARTIN E. PICCUS, GARY A. SMITH, BRIAN K. STANDLEY, TAMI L. VOLK, and LINDA B. WILDES Dec. 1993 325 p  
 (AD-A273865; AFIT/GSE/ENY/93D-2) Avail: CASI HC A14/MF A03

The objective of this research is to develop a process which will analyze and group human faces, concentrating on the oxygen mask seal area, into a minimum number of generic yet distinct face types. The shape and size, or form, of the face is described by bending energies. This bending energy provides the features for the grouping of similar face types, while distinguishing representatives for each cluster. The face tariffs are the percentage of faces grouped under a representative face. The representative faces are then transformed into three-dimensional solids using computer-aided design. A rapid prototype creates the solids or plugs from which MBU5/P masks are made and tested. The two major outcomes of this research are a formal morphological method which allows the comparison between multiple faces, and a process

to transform anthropomorphic surfaces into a prototype mask mold. DTIC

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#### **VARIABLE SPEED CONTROLLER**

CHRISTA ESTES, CHARLES SPIGGLE, SHANNON SWIFT, STEPHEN VANGEFFEN, and FRANK YOUNGER *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 90-95 1992  
 Avail: CASI HC A01/MF A04

This report details a new design for a variable speed controller which can be used to operate lunar machinery without the astronaut using his or her upper body. In order to demonstrate the design, a treadle for an industrial sewing machine was redesigned to be used by a standing operator. Since the invention of an electrically powered sewing machine, the operator has been seated. Today, companies are switching from sit down to stand up operation involving modular stations. The old treadle worked well with a sitting operator, but problems have been found when trying to use the same treadle with a standing operator. Emphasis is placed on the ease of use by the operator along with the ergonomics involved. Included with the design analysis are suggestions for possible uses for the speed controller in other applications.

Author

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#### **ENABLER OPERATOR STATION**

ANDREA BAILEY, JOHN KIETZMAN, SHIRLYN KING, RAE STOVER, and TORSTEN WEGNER *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 96-101 1992  
 Avail: CASI HC A01/MF A04

The objective of this project was to design an onboard operator station for the conceptual Lunar Work Vehicle (LWV). The LWV would be used in the colonization of a lunar outpost. The details that follow, however, are for an Earth-bound model. The operator station is designed to be dimensionally correct for an astronaut wearing the current space shuttle EVA suit (which include life support). The proposed operator station will support and restrain an astronaut as well as to provide protection from the hazards of vehicle rollover. The threat of suit puncture is eliminated by rounding all corners and edges. A step-plate, located at the front of the vehicle, provides excellent ease of entry and exit. The operator station weight requirements are met by making efficient use of rigid members, semi-rigid members, and woven fabrics. Author

**N94-25680\*#** Georgia Inst. of Tech., Atlanta. School of Textile and Fiber Engineering.

#### **DUST CONTROL FOR ENABLER**

KEVIN HILTON, CHAD KARL, MARK LITHERLAND, DAVID RITCHIE, and NANCY SUN *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 101-107 1992  
 Avail: CASI HC A02/MF A04

The dust control group designed a system to restrict dust that is disturbed by the Enabler during its operation from interfering with astronaut or camera visibility. This design also considers the many different wheel positions made possible through the use of articulation joints that provide the steering and wheel pitching for the Enabler. The system uses a combination of brushes and fenders to restrict the dust when the vehicle is moving in either direction and in a turn. This design also allows for ease of maintenance as well as accessibility of the remainder of the vehicle. Author

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#### **PORTABLE HABITAT FOR ANTARCTIC SCIENTIFIC RESEARCH (PHASR)**

SAMANTHA S. GRISWOLD *In* USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design

## 54 MAN/SYSTEM TECHNOLOGY AND LIFE SUPPORT

Program p 108-113 1992  
Avail: CASI HC A02/MF A04

The Portable Habitat for Antarctic Scientific Research, PHASR, is designed as a versatile, general purpose habitat system that addresses the problem of functional space and environmental soundness in a partially fabric-covered shelter. PHASR is used for remote field site applications that can be quickly deployed. PHASR will also provide four scientists with a comfortable and efficient use of interior space. PHASR is a NASA/USRA Advanced Design Program project conducted at the University of Houston College of Architecture, Sasadawa International Center for Space Architecture (SICSA). This report is prepared for NASA/USRA.

Author

**N94-25684\*#** Kansas State Univ., Manhattan. Dept. of Mechanical Engineering.

### **AUTOMATION OF CLOSED ENVIRONMENTS IN SPACE FOR HUMAN COMFORT AND SAFETY**

ALLEN C. COGLEY and NATHAN P. TUCKER /n USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 137-145 1992

Avail: CASI HC A02/MF A04

For prolonged missions into space and colonization outside the Earth's atmosphere, development of Environmental Control and Life Support Systems (ECLSS) are essential to provide astronauts with habitable environments. The Kansas State University Advanced Design Team have researched and designed a control system for an ECLSS like that on Space Station Freedom. The following milestones have been accomplished: (1) completed computer simulation of the CO<sub>2</sub> Removal Assembly; (2) created a set of rules for the expert control system of the CO<sub>2</sub> Removal Assembly; (3) created a classical controls system for the CO<sub>2</sub> Removal Assembly; (4) established a means of communication between the mathematical model and the two controls systems; and (5) analyzed the dynamic response of the simulation and compared the two methods of control.

Author

**N94-25693\*#** Prairie View Agricultural and Mechanical Coll., TX. Dept. of Architecture.

### **DESIGN AND DEVELOPMENT OF THE SECOND GENERATION MARS HABITAT**

IKHLAS SABOUNI, ROY SMITH, STEVEN TAYLOR, BROCK HARRELL, and EARNEST CRAWFORD /n USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 228-236 1992

Avail: CASI HC A02/MF A04

The second generation of Mars Habitat is to be utilized as an advanced permanent base for 20 crew members to live on Mars for a period of 6-12 months. It is designed to be a self-contained environment accommodating five main facilities: living, working, service, medical, and a greenhouse. The objective of the design is to create a comfortable, safe, living environment. Hexamars-2 and Lavalopolis-2 are two different concepts for the advanced Mars Habitat. The design team assumes there will be an initial habitat located near or on the site from earlier missions that satisfies the requirement for a short-term habitation for the crew to use while constructing Hexamars-2 or Lavalopolis-2. Prefabricated structures and materials will be shipped to the site before the long-term crew members arrive. Partial construction and preparation for the long-term habitat will be done by crew members or robotics from a previous mission. The construction of the long-term base will occur in phases. Hexamars-2 consists of six sphere-shaped inflatable modules that will be partially buried below the Martian surface. The construction of each sphere will occur in ten steps. Shape charges will be used to create the crater in which the spherical structure will be placed. The interior core will be unloaded and put into place followed by the exterior structure. The foundation will be filled, the interior bladder will be inflated, floor-to-floor joists connected, and sand pockets filled. Finally, the life support system and interior partitions are put in place. Each sphere consists of three levels of which the lower level will be safe haven. Particular attention is given to structural support, the dominance of internal

pressure, the process of construction, and human factors.

Author (revised)

**N94-25694\*#** Puerto Rico Univ., Rio Piedras. School of Architecture.

### **FIRST LUNAR OUTPOST**

AUREO F. ANDINO, DANIEL SILVA, NELSON ORTIZ, OMAR ALVAREZ, JULIO A. COLON, MYRELLE COLON, ALICIA DIAZ, XOCHIQUETZAL Y. ESCOBAR, ALBERTO GARCIA, ISABEL C. GONZALEZ et al. /n USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 237-249 1992

Avail: CASI HC A03/MF A04

Design and research efforts at the University of Puerto Rico have focused on the evaluation and refinement of the Habitability Criteria for a prolonged human presence in space during the last four years. Living quarters for a Mars mission and a third generation lunar base concept were proposed. This academic year, 1991-92, work on further refinement of the habitability criteria and design of partial gravity furniture was carried on. During the first semester, design alternatives for furniture necessary in a habitat design optimized for lunar and Martian environments were developed. Designs are based on recent research data from lunar and Mars gravity simulations, and current NASA standards. Artifacts will be submitted to NASA architects to be tested in KC-135 flights. Test findings will be submitted for incorporation in future updates to NASA habitat design standards. Second semester work was aimed at integrating these findings into the First Lunar Outpost (FLO), a mission scenario currently being considered by NASA. The mission consists of a manned return to the moon by crews of four astronauts for periods of 45 days. The major hardware components of the mission are as follows: (1) a Crew Module for the delivery of the crew and their supplies, and (2) the Habitat Module, which will arrive on the Moon unmanned. Our design efforts concentrated on this Habitat Module and on application of habitability criteria. Different geometries for the pressure vessel and their impact on the interior architecture were studied. Upon the selection of a geometry, a more detailed analysis of the interior design was performed, taking into consideration the reduced gravity, and the protection against radiation, micrometeorites, and the extreme temperature variation. A proposal for a FLO was submitted by the students, consisting essentially of a 24-feet (7.3 m.) by 35-feet (10.67 m) high vertical cylinder with work areas, crew quarters, galley, wardroom, leisure facilities, health maintenance, waste management, EVA operations facilities, and safe havens.

Author (revised)

**N94-25698\*#** Texas Univ., Austin. Dept. of Mechanical Engineering.

### **THE 1991-1992 PROJECT SUMMARIES**

STEVEN P. NICHOLS and HANK KLEESPIES /n USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 267-270 1992

Avail: CASI HC A01/MF A04

The Department of Mechanical Engineering at The University of Texas at Austin participated in seven cooperative design projects this year. Six of the projects were associated with the Johnson Space Center and include the design of a thermal control system for an inflatable lunar habitat module, a vibration isolation system for a space shuttle cycle ergometer, a radiator shading device for a lunar outpost, a reusable astronaut safety tether, a resistive exercise device for use on the space shuttle, and a fleet of autonomous regolith throwing devices for radiation shielding of lunar habitats. The seventh project is associated with the Jet Propulsion Lab and involves the design of a shock absorbing wheel for a small six-wheeled Martian rover vehicle.

Author (revised)

**N94-25706\*#** Wisconsin Univ., Milwaukee. Dept. of Architecture.

### **PAX: A PERMANENT BASE FOR HUMAN HABITATION OF MARS**

GARY T. MOORE, PATRICK J. REBHOLZ, JOSEPH P. FIEBER,

JANIS HUEBNER-MOTHS, and KERRY L. PARULESKI In USRA, Proceedings of the 8th Annual Summer Conference: NASA/USRA Advanced Design Program p 343-357 1992  
 Avail: CASI HC A03/MF A04

The Advanced Design Program in Space Architecture at the University of Wisconsin-Milwaukee supported the synthesis report and two of its scenarios - 'Architecture 1' and 'Architecture 4' - and the Weaver ExPO report on near-term extraterrestrial explorations during the spring of 1992. The project investigated the implications of different mission scenarios, the Martian environment, supporting technologies, and especially human factors and environment-behavior considerations for the design of the first permanent Martian base. This paper presents the results of that investigation. The paper summarizes site selection, development of habitability design requirements based on environment-behavior research, construction sequencing, and a full concept design and design development for a first permanent Martian base and habitat. The proposed design is presented in terms of an integrative mission scenario and master plan phased through initial operational configuration, base site plan, and design development details of a complete Martian habitat for 18 crew members including all laboratory, mission control, and crew support spaces.

Author (revised)

**N94-25724#** Institute for Perception RVO-TNO, Soesterberg (Netherlands).

**THE EFFECT OF PLATFORM MOTION ON HUMAN ENERGY EXPENDITURE DURING WALKING. AN EXPLORATORY EXPERIMENT Final Report**

A. H. WERTHEIM, R. HEUS, T. G. VRIJKOTTE, and J. T. MARCUS 11 Aug. 1993 20 p  
 (AD-A273760; IZF-1993-B-10; TDCK-TD-93-1366) Avail: CASI HC A03/MF A01

An experiment was performed in which various physiological measures of energy expenditure were taken with subjects walking for periods of 10 minutes (either freely or on a treadmill) on a moving platform (Ship Motion Simulator). Platform motion was either in a heave, pitch or roll mode, or it was stationary. The results show that during pitch and roll movements of the platform energy expenditure is larger than during heave motions and when the platform remained stationary. Pitch and roll did not differ from each other, and neither did heave and stationary conditions. The results are interpreted as indicating that the muscular effort needed for the maintenance of balance when walking on a pitching or rolling platform requires a significant increase in energy expenditure.

DTIC

**N94-26136#** Federal Aviation Administration, Oklahoma City, OK. Civil Aeromedical Inst.

**HUMAN FACTORS IN AIRWAY FACILITIES MAINTENANCE: DEVELOPMENT OF A PROTOTYPE OUTAGE ASSESSMENT INVENTORY Final Report**

ROBERT E. BLANCHARD and JENNIFER J. VARDAMAN Feb. 1994 25 p Prepared for FAA, Atlantic City, NJ  
 (DOT/FAA/AM-94/5) Avail: CASI HC A03/MF A01

The airway facilities (AF) maintenance community is concerned with identifying ways of reducing both the incidence of equipment failure and the amount of time required to restore equipment to operational status following a failure. It is vitally important to identify the many components of downtime and contributors to a particular outage (equipment failure). Thus, the primary objective was to develop a technique or tool with which to identify and map within a 'systems' structure all potentially-significant contributors to AF maintenance downtime. The technique was designed to facilitate (1) the collection of maintenance-related data during an actual outage; (2) the entry of this data into a data base; and (3) the analysis of the data base in order to identify causal relationships. The secondary objective was to be able to make use of past outage data as a means for building the data base by determining whether overall outage time values can be apportioned among the contributors to downtime using subject matter experts (SME's) who were intimately involved in restoring a given outage. SME's from the Oklahoma City (OKC) General National Airspace System

(GNAS) Airway Facilities Sector (AFS) and the Memphis GNAS AFS assisted in the iterative design and review process that produced the Airway Facilities Outage Assessment Inventory - Form A (AFOAI). Ten previous OKC GNAS outages and four previous Memphis GNAS outages were analyzed using the AFOAI - Form A, thus confirming that the inventory is a useful tool in identifying specific contributors to AF maintenance downtime. Recommendations were to continue to refine the format of the AFOAI and to install it on a trial basis to test its usefulness in collecting and analyzing data on factors and conditions contributing to facility outages.

Author (revised)

## 55

### SPACE BIOLOGY

Includes exobiology; planetary biology; and extraterrestrial life.

**N94-26098\*#** National Aeronautics and Space Administration. Ames Research Center, Moffett Field, CA.

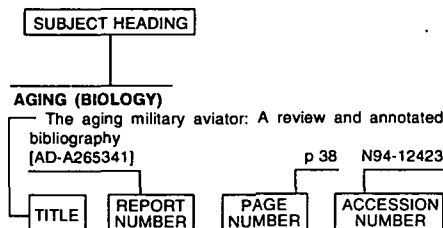
**INTERMITTENT GRAVITY: HOW MUCH, HOW OFTEN, HOW LONG?**

JOAN VERNIKOS and DAVID A. LUDWIG (North Carolina Univ., Greensboro.) Jan. 1994 106 p  
 (Contract RTOP 199-14-12-11)  
 (NASA-TM-108800; A-94027; NAS 1.15:108800) Avail: CASI HC A06/MF A02

Continuous exposure to gravity may not be necessary to prevent the deconditioning effects of microgravity. It is not known, however, what the minimum gravity (G) exposure requirements are, whether they vary for different physiological systems, or whether passive Gz (gravity in the head-to-toe vector) or activity in a G field is more effective in preventing deconditioning. It is also not known what the optimal characteristics of the G stimulus should be in terms of amplitude, duration, and frequency. To begin to address these questions, a 4-day -6 deg head-down bed rest (HDBR) study was conducted. Nine males (aged 30-50 yr) were subjected, over a period of seven months, to four different +1 Gz exposure protocols (periodic standing or controlled walking each for a total of 2 or 4 hr/day in individual 15-min doses), plus a control (0 Gz) of continuous HDBR. The study consisted of one ambulatory control day, 4 full days of -6 deg HDBR, and a recovery day when subjects were released at the end of HDBR after completion of tests. A battery of tests was selected and standardized in order to evaluate the known early responses to HDBR. Dependent variables of interest included orthostatic tolerance (30 min at 60 deg head-up tilt) and hemodynamics during head-up tilt, peak oxygen consumption (VO2(sub peak)) plasma volume (PV), and urinary calcium (Ca). The results were as follows: 4 hr standing completely prevented and 2 hr walking partially prevented post-HDBR orthostatic intolerance. Walking at 3 mi/hr for 4 hr/day provided no additional benefit. Intermittent walking attenuated, but did not prevent, the decrease in VO2(sub peak). Both 4 hr conditions showed less PV loss by the end of HDBR; both 2 hr conditions were without effect. Both 2 and 4 hr walking essentially prevented urinary Ca excretion and were more effective than standing. It is concluded that different physiological systems benefit differentially from passive +1 Gz or activity in +1 Gz, and the intensity of the stimulus may be an important contributing factor.

Author (revised)

### Typical Subject Index Listing



The subject heading is a key to the subject content of the document. The title is used to provide a description of the subject matter. When the title is insufficiently descriptive of document content, a title extension is added, separated from the title by three hyphens. The accession number and the page number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document. Under any one subject heading, the accession numbers are arranged in sequence.

## A

### ABSORPTION SPECTROSCOPY

Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### ACCELERATION STRESSES (PHYSIOLOGY)

Artificial gravity in space flight p 134 N94-24928 [AD-A273420]

### ADENOSINE TRIPHOSPHATE

The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium [NASA-CR-193803] p 131 N94-24807  
The evolution of energy-transducing systems. Studies with archaeobacteria [NASA-CR-195129] p 131 N94-24811

### AEROSPACE ENVIRONMENTS

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426  
Automation of closed environments in space for human comfort and safety p 154 N94-25684

### AEROSPACE MEDICINE

Visual Problems in Night Operations [AGARD-LS-187] p 141 N94-23976  
Index to FAA Office of Aviation Medicine Reports: 1961 through 1993 [DOT/FAA/AM-94/1] p 133 N94-24093  
EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171] p 138 N94-24799  
Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom [NASA-CR-195508] p 149 N94-24835  
Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378  
Loading, electromyograph, and motion during exercise p 135 N94-25380

Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781] p 133 N94-26093

### AIR FILTERS

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310

### AIRBORNE/SPACEBORNE COMPUTERS

Spacecraft crew procedures from paper to computers p 143 N94-24186

### AIRCRAFT CONTROL

Proceedings of the Workshop on Augmented Visual Display (AVID) Research [NASA-CP-10128] p 151 N94-25490

### AIRCRAFT LANDING

Optical information in landing scenes p 152 N94-25511

### ALERTNESS

Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

### ALTERNATIVES

Proceedings of the symposium on current concepts and approaches on animal test alternatives [AD-A273926] p 132 N94-25593

### ANIMALS

Proceedings of the symposium on current concepts and approaches on animal test alternatives [AD-A273926] p 132 N94-25593  
An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086

### ANTARCTIC REGIONS

Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681

### ANTHROPOMETRY

Hand controller commonality evaluation process p 145 N94-24197  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206  
Development of a force feedback anthropomorphic teleoperation input device for control of robot hands [NASA-CR-195109] p 147 N94-24329  
Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667  
Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956  
Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

### APPLICATIONS PROGRAMS (COMPUTERS)

Using computer graphics to design Space Station Freedom viewing p 144 N94-24191  
EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

### ARCHAEBACTERIA

The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium [NASA-CR-193803] p 131 N94-24807  
The evolution of energy-transducing systems. Studies with archaeobacteria [NASA-CR-195129] p 131 N94-24811

### ARTERIES

EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

### ARTIFICIAL GRAVITY

Artificial gravity in space flight [AD-A273420] p 134 N94-24928

### ARTIFICIAL INTELLIGENCE

Intelligent tutoring and aiding in satellite ground control p 140 N94-23929  
Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438

### ASSAYING

Evaluation of ovostatin and ovostatin assay p 130 N94-24437

### ASTRONAUT PERFORMANCE

Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227  
The role of visual context in manual target localization p 138 N94-25351

### ASTRONAUTS

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185  
Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667

### ATROPHY

Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082] p 129 N94-24124

### ATTENTION

Pacing visual attention: Temporal structure effects [AD-A273859] p 140 N94-25965

### AUDITORY PERCEPTION

Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

### AUDITORY SIGNALS

Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

### AUTONOMY

An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369  
Autonomous support for microorganism research in space p 132 N94-25672  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077] p 139 N94-25774

## B

### BACTERIA

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310  
Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791  
The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium [NASA-CR-193803] p 131 N94-24807  
Design and testing of a unique randomized-gravity, continuous flow bioreactor p 132 N94-25368  
Autonomous support for microorganism research in space p 132 N94-25672

### BANDWIDTH

Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970

### BED REST

Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098

### BENDING THEORY

Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

### BIOASTRONAUTICS

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185  
Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom [NASA-CR-195508] p 149 N94-24835  
Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956  
Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378  
Loading, electromyograph, and motion during exercise p 135 N94-25380  
Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781] p 133 N94-26093

## BIODYNAMICS

### BIODYNAMICS

Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data

p 144 N94-24193

Hand controller commonality evaluation process

p 145 N94-24197

Development of biomechanical models for human factors evaluations

p 146 N94-24205

Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study

p 147 N94-24206

### BIOFEEDBACK

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785]

p 133 N94-24102

### BIOINSTRUMENTATION

A chemical sensor and biosensor based totally automated water quality monitor for extended space flight: Step 1

p 148 N94-24447

Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight

p 135 N94-25378

### BIOLOGICAL EVOLUTION

The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium [NASA-CR-193803]

p 131 N94-24807

### BIOLOGY

A biological survey for the nation [LC-93-85920]

p 130 N94-24704

### BIOMASS

Investigating pyrolysis/incineration as a method of resource recovery from solid waste

p 151 N94-25375

### BIOREACTORS

Non-invasive optical detection of glucose in cell culture nutrient medium

p 131 N94-25357

Design and testing of a unique randomized gravity, continuous flow bioreactor

p 132 N94-25368

### BLOOD FLOW

Development of a model to assess orthostatic responses

p 135 N94-25376

EcarHeart2 version 1.0: Programmers documentation [PB94-124633]

p 136 N94-25909

### BLOOD PRESSURE

Development of a model to assess orthostatic responses

p 135 N94-25376

### BLOOD VOLUME

Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781]

p 133 N94-26093

### BODY TEMPERATURE

Rewarming methodologies in the field [AD-A274744]

p 136 N94-26173

### BONE DEMINERALIZATION

Loading, electromyograph, and motion during exercise

p 134 N94-25359

### BONES

Loading, electromyograph, and motion during exercise

p 134 N94-25359

### BRAIN

Interaction of tacrine at M(1) and M(2) cholinceptors in guinea pig brain

p 129 N94-24294

The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation [AD-A274086]

p 136 N94-25943

### BREATHING APPARATUS

Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research [DCIEM-93-05]

p 147 N94-24299

Rewarming methodologies in the field [AD-A274744]

p 136 N94-26173

### BRIGHTNESS

Luminance-brightness mapping: The missing decades [ETN-94-95351]

p 138 N94-25298

Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761]

p 135 N94-25871

### BRIGHTNESS DISCRIMINATION

Luminance-brightness mapping: The missing decades [ETN-94-95351]

p 138 N94-25298

## C

### CAFFEINE

Thermoregulatory effects of caffeine ingestion during rest and exercise in men [NASA-TM-108783]

p 133 N94-26210

### CAMERAS

Speech versus manual control of camera functions during a telerobotic task

p 145 N94-24199

The effects of spatially displaced visual feedback on remote manipulator performance

p 146 N94-24201

Multiple-camera/motion stereoscopy for range estimation in helicopter flight

p 151 N94-25505

A model-based approach for detection of objects in low resolution passive-millimeter wave images

p 151 N94-25507

### CANCER

Annual research progress report, fiscal year 1992. Volume 2: Department of Clinical Investigation [AD-A273584]

p 134 N94-24945

### CARBOHYDRATE METABOLISM

Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082]

p 129 N94-24124

### CARBON DIOXIDE REMOVAL

Automation of closed environments in space for human comfort and safety

p 154 N94-25684

### CARDIOVASCULAR SYSTEM

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785]

p 133 N94-24102

Development of a model to assess orthostatic responses

p 135 N94-25376

EcarHeart2 version 1.0: Programmers documentation [PB94-124633]

p 136 N94-25909

### CELLS (BIOLOGY)

Measuring the dynamics of structural changes in biological macromolecules from light scattering data

p 130 N94-24426

An exploratory stochastic model for toxic effects on cells [AD-A273438]

p 131 N94-25146

Non-invasive optical detection of glucose in cell culture nutrient medium

p 131 N94-25357

Design and testing of a unique randomized gravity, continuous flow bioreactor

p 132 N94-25368

### CENTRAL NERVOUS SYSTEM

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488]

p 134 N94-24950

### CENTRAL NERVOUS SYSTEM STIMULANTS

Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896]

p 136 N94-26179

### CENTRIFUGES

An automatic 14-day paste diet feeder for animals [NASA-TM-108804]

p 133 N94-26086

### CENTRIFUGING

An automatic 14-day paste diet feeder for animals [NASA-TM-108804]

p 133 N94-26086

### CERTIFICATION

Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2]

p 149 N94-24830

### CHAOS

EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171]

p 138 N94-24799

### CHARACTER RECOGNITION

Image remapping strategies applied as prostheses for the visually impaired

p 150 N94-25363

### CHEMICAL ANALYSIS

Bioregenerative life support systems for microgravity [NASA-CR-195516]

p 131 N94-24810

The evolution of energy-transducing systems. Studies with archaeobacteria [NASA-CR-195129]

p 131 N94-24811

### CHEMICAL WARFARE

Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06]

p 142 N94-24119

### CHICKENS

Evaluation of ovostatin and ovostatin assay

p 130 N94-24437

### CHOLINE

Interaction of tacrine at M(1) and M(2) cholinceptors in guinea pig brain

p 129 N94-24294

### CHOLINERGICS

Interaction of tacrine at M(1) and M(2) cholinceptors in guinea pig brain

p 129 N94-24294

### CINEMATOGRAPHY

Quantitative assessment of human motion using video motion analysis

p 146 N94-24203

### CLINICAL MEDICINE

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785]

p 133 N94-24102

Annual research progress report, fiscal year 1992. Volume 2: Department of Clinical Investigation [AD-A273584]

p 134 N94-24945

### CLOSED ECOLOGICAL SYSTEMS

Microbial biofilm formation and its consequences for the CELSS program [NASA-CR-195146]

p 148 N94-24706

Bioregenerative life support systems for microgravity [NASA-CR-195516]

p 131 N94-24810

Robotics in a controlled, ecological life support system

p 150 N94-25371

Automation of closed environments in space for human comfort and safety

p 154 N94-25684

### CLUSTER ANALYSIS

Process and representation in graphical displays

p 143 N94-24187

Designers' models of the human-computer interface

p 143 N94-24188

### COCKPITS

Cockpit/NVG visual integration issues

p 142 N94-23983

Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2]

p 149 N94-24830

### COGNITION

Multi-sensoral approach to night flight: Perceptive and Cognitive limitations

p 141 N94-23981

### COGNITIVE PSYCHOLOGY

Mental images

p 137 N94-23980

Process and representation in graphical displays

p 143 N94-24187

The use of analytical models in human-computer interface design

p 143 N94-24190

### COLONIES

Symbiosis in marine luminous bacteria [AD-A273540]

p 130 N94-24791

### COLOR

Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES

p 140 N94-23936

Endogeneous and exogenous control of visual selection: A review of the literature [AD-A273761]

p 135 N94-25871

### COLOR VISION

Endogeneous and exogenous control of visual selection: A review of the literature [AD-A273761]

p 135 N94-25871

### COMBAT

Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077]

p 139 N94-25774

### COMPUTER AIDED DESIGN

Development of biomechanical models for human factors evaluations

p 146 N94-24205

Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865]

p 153 N94-25611

### COMPUTER ANIMATION

Development of biomechanical models for human factors evaluations

p 146 N94-24205

### COMPUTER ASSISTED INSTRUCTION

Intelligent tutoring and aiding in satellite ground control

p 140 N94-23929

Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE)

p 136 N94-23933

Training: Plugging the information gaps

p 136 N94-23934

Evaluation of computer-aided instruction techniques for the crew interface coordination position

p 137 N94-24438

### COMPUTER GRAPHICS

Night vision goggle illusions and visual training

p 142 N94-23984

Using computer graphics to design Space Station Freedom viewing

p 144 N94-24191

### COMPUTER PROGRAMS

Quantitative assessment of human motion using video motion analysis

p 146 N94-24203

### COMPUTER TECHNIQUES

EcarHeart2 version 1.0: Programmers documentation [PB94-124633]

p 136 N94-25909

### COMPUTER VISION

Multi-sensoral approach to night flight: Perceptive and Cognitive limitations

p 141 N94-23981

Proceedings of the Workshop on Augmented Visual Display (AVID) Research [NASA-CP-10128]

p 151 N94-25490

### COMPUTERIZED SIMULATION

The use of analytical models in human-computer interface design

p 143 N94-24190

Using computer graphics to design Space Station Freedom viewing

p 144 N94-24191

Simulation of the human-telerobot interface on the Space Station

p 146 N94-24202

Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study

p 147 N94-24206

Engineering workstation: Sensor modeling

p 151 N94-25500

Automation of closed environments in space for human comfort and safety

p 154 N94-25684

### CONCENTRATION (COMPOSITION)

Bioregenerative life support systems for microgravity [NASA-CR-195516]



## SUBJECT INDEX

### CONFERENCES

Proceedings of the symposium on current concepts and approaches on animal test alternatives  
[AD-A273926] p 132 N94-25593

### CONFORMAL MAPPING

Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

### CONSTRUCTION

A simulation system for Space Station extravehicular activity p 144 N94-24192  
Design and development of the second generation Mars Habitat p 154 N94-25693

### CONTAMINATION

Microbial biofilm formation and its consequences for the CELSS program  
[NASA-CR-195146] p 148 N94-24706

### CONTROL BOARDS

Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198

### CONTROL EQUIPMENT

Variable speed controller p 153 N94-25678

### CONTROL SYSTEMS DESIGN

Automation of closed environments in space for human comfort and safety p 154 N94-25684

### CONTROL VALVES

Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research  
[DCIEM-93-05] p 147 N94-24299

### CONTROLLED ATMOSPHERES

Automation of closed environments in space for human comfort and safety p 154 N94-25684

### CONTROLLERS

Hand controller commonality evaluation process p 145 N94-24197  
Variable speed controller p 153 N94-25678

### COOLING SYSTEMS

Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew  
[DCIEM-93-06] p 142 N94-24119

### COUCHES

Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667  
Design of a recumbent seating system  
[NASA-CR-195503] p 148 N94-24786

### COUPLINGS

Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

### CREW PROCEDURES (INFLIGHT)

Spacecraft crew procedures from paper to computers p 143 N94-24186

### CROP GROWTH

Robotics in a controlled, ecological life support system p 150 N94-25371

### CULTURE TECHNIQUES

Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

## D

### DATA ACQUISITION

Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data p 144 N94-24193

Design and simulation of EVA tools for first servicing mission of HST  
[NASA-CR-194784] p 149 N94-24857

Autonomous support for microorganism research in space p 132 N94-25672

### DATA BASES

Previous experience in manned space flight: A survey of human factors lessons learned p 144 N94-24196

### DATA INTEGRATION

Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications p 152 N94-25512

### DEBRIS

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2  
[NASA-CR-193683] p 129 N94-24310

### DECISION MAKING

Quality metrics for sensor images p 152 N94-25513  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation  
[AD-A274077] p 139 N94-25774

### DEFECTS

Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

### DEPTH

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure  
[AD-A273488] p 134 N94-24950

### DESIGN ANALYSIS

Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936

The use of analytical models in human-computer interface design p 143 N94-24190

### DETECTION

A chemical sensor and biosensor based totally automated water quality monitor for extended space flight: Step 1 p 148 N94-24447

A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507

### DIASTOLIC PRESSURE

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews  
[NASA-TM-108785] p 133 N94-24102

### DIGITAL SYSTEMS

Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation  
[DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830

### DISPLAY DEVICES

Night operations p 141 N94-23977  
Process and representation in graphical displays p 143 N94-24187

Proceedings of the Workshop on Augmented Visual Display (AVID) Research  
[NASA-CP-10128] p 151 N94-25490

Optical information in landing scenes p 152 N94-25511

Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications p 152 N94-25512

Quality metrics for sensor images p 152 N94-25513  
Evaluation of image quality p 153 N94-25514

### DISRUPTING

Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption  
[FOA-B-40418-4.4] p 129 N94-24290

### DIVING (UNDERWATER)

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure  
[AD-A273488] p 134 N94-24950

### DOWNTIME

Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory  
[DOT/FAA/AM-94/5] p 155 N94-26136

### DUST

Dust collector for Enabler p 153 N94-25680

Dust control for Enabler p 153 N94-25680

### DYNAMIC MODELS

An exploratory stochastic model for toxic effects on cells  
[AD-A273438] p 131 N94-25146

### DYNAMOMETERS

NASA project 1: Full-body dynamometer  
[NASA-CR-195507] p 148 N94-24331

Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom  
[NASA-CR-195508] p 149 N94-24835

## E

### EARTH ATMOSPHERE

Automation of closed environments in space for human comfort and safety p 154 N94-25684

### EDUCATION

Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933

Training: Plugging the information gaps p 136 N94-23934

Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438

### EGGS

Evaluation of ovostatin and ovostatin assay p 130 N94-24437

### ELECTRICAL IMPEDANCE

Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378

### ELECTRODES

The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation  
[AD-A274086] p 136 N94-25943

### ELECTROENCEPHALOGRAPHY

EEG and chaos: Description of underlying dynamics and its relation to dissociative states  
[NASA-CR-195171] p 138 N94-24799

## EXTRAVEHICULAR ACTIVITY

The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation  
[AD-A274086] p 136 N94-25943

### ELECTROMYOGRAPHY

Loading, electromyograph, and motion during exercise p 134 N94-25359

Loading, electromyograph, and motion during exercise p 135 N94-25380

### ELECTRONIC CONTROL

Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research  
[DCIEM-93-05] p 147 N94-24299

### EMPLOYEE RELATIONS

Perceptions of organizational support and affectivity as predictors of job satisfaction  
[DOT/FAA/AM-94/2] p 139 N94-25442

### END EFFECTORS

Development of a force feedback anthropomorphic teleoperation input device for control of robot hands  
[NASA-CR-195109] p 147 N94-24329

### ENVIRONMENT SIMULATION

A white paper: NASA virtual environment research, applications, and technology  
[NASA-TM-109682] p 138 N94-24855

### ENVIRONMENTAL CONTROL

Automation of closed environments in space for human comfort and safety p 154 N94-25684

### ENZYME ACTIVITY

The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811

### ENZYMES

The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium  
[NASA-CR-193803] p 131 N94-24807

### ENZYMOLGY

The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811

### ERGOMETERS

Loading, electromyograph, and motion during exercise p 135 N94-25380

The 1991-1992 project summaries p 154 N94-25698

### ERYTHROCYTES

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

### ESCAPE SYSTEMS

Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

### ETHYL COMPOUNDS

The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811

### EUKARYOTES

Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption  
[FOA-B-40418-4.4] p 129 N94-24290

### EXERCISE PHYSIOLOGY

Loading, electromyograph, and motion during exercise p 135 N94-25380

The effect of platform motion on human energy expenditure during walking. An exploratory experiment  
[AD-A273760] p 155 N94-25724

Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt  
[NASA-TM-108781] p 133 N94-26093

### EXOBIOLGY

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

Autonomous support for microorganism research in space p 132 N94-25672

### EXPERT SYSTEMS

Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438

Automation of closed environments in space for human comfort and safety p 154 N94-25684

Developing realistic cooperative behaviors for autonomous agents in air combat simulation  
[AD-A274077] p 139 N94-25774

### EXTRAVEHICULAR ACTIVITY

A simulation system for Space Station extravehicular activity p 144 N94-24192

Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

Design and simulation of EVA tools for first servicing mission of HST  
[NASA-CR-194784] p 149 N94-24857



## EXTRAVEHICULAR MOBILITY UNITS

- Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences p 150 N94-25354  
An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369

**EXTRAVEHICULAR MOBILITY UNITS**  
Enabler operator station p 153 N94-25679

## F

### FACTOR ANALYSIS

- A test of the theory of reasoned action at the group level of analysis [AD-A273965] p 139 N94-25897

### FAILURE MODES

- Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830

### FALLOUT

- Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

### FEEDBACK CONTROL

- The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201  
Bioregenerative system components for microgravity p 132 N94-25673

### FEEDERS

- An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086

### FIELD OF VIEW

- Night vision devices and characteristics p 141 N94-23982

### FILTRATION

- Bioregenerative system components for microgravity p 132 N94-25673

### FINITE ELEMENT METHOD

- Loading, electromyograph, and motion during exercise p 135 N94-25380

### FLIGHT CLOTHING

- Physiological protection for aircrew at high altitudes: A review of the literature [DCIEM-93-13] p 142 N94-24114  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119

### FLIGHT CONTROL

- Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830

### FLIGHT CREWS

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979  
Image processing for flight crew enhanced situation awareness p 152 N94-25508

### FLIGHT HAZARDS

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979

### FLIGHT OPERATIONS

- Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933  
Engineering workstation: Sensor modeling p 151 N94-25500

### FLIGHT PATHS

- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

### FLIGHT SAFETY

- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

### FLIGHT SIMULATION

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227  
A simulation study of control and display requirements for zero-experience general aviation pilots p 149 N94-25102  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077] p 139 N94-25774

### FLIGHT SIMULATORS

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227  
Pilot evaluation system p 137 N94-24266  
A simulation study of control and display requirements for zero-experience general aviation pilots p 149 N94-25102  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077] p 139 N94-25774

## FLIGHT TESTS

- Synthetic vision system flight test results and lessons learned p 139 N94-25492

## FLIGHT TRAINING

- Pilot evaluation system p 137 N94-24266

## FOCUSING

- Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970

## FOOD PROCESSING

- Bioregenerative system components for microgravity p 132 N94-25673

## FOVEA

- Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974  
Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

## FUNCTIONAL DESIGN SPECIFICATIONS

- Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786  
Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom [NASA-CR-195508] p 149 N94-24835

## G

### GENERAL AVIATION AIRCRAFT

- A simulation study of control and display requirements for zero-experience general aviation pilots p 149 N94-25102

### GENETIC CODE

- Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290

### GLIDE PATHS

- Optical information in landing scenes p 152 N94-25511

### GLOVES

- Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences p 150 N94-25354

### GLUCOSE

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### GOGGLES

- Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974  
Night operations p 141 N94-23977  
Night vision devices and characteristics p 141 N94-23982  
Cockpit/NVG visual integration issues p 142 N94-23983  
Night vision goggle illusions and visual training p 142 N94-23984

### GRAPHICAL USER INTERFACE

- Intelligent tutoring and aiding in satellite ground control p 140 N94-23929  
Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936  
Automated system function allocation and display format: Task information processing requirements p 143 N94-24189

### GRAPHS (CHARTS)

- Process and representation in graphical displays p 143 N94-24187

### GRAVITATIONAL EFFECTS

- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204  
The role of visual context in manual target localization p 138 N94-25351  
Development of a model to assess orthostatic responses p 135 N94-25376  
Autonomous support for microorganism research in space p 132 N94-25672  
Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098

### GRAVITATIONAL PHYSIOLOGY

- Artificial gravity in space flight [AD-A273420] p 134 N94-24928  
The role of visual context in manual target localization p 138 N94-25351  
Loading, electromyograph, and motion during exercise p 134 N94-25359  
Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098

### GROUND BASED CONTROL

- Intelligent tutoring and aiding in satellite ground control p 140 N94-23929

## SUBJECT INDEX

- Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933

## GROUND CREWS

- Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438

## GROUP DYNAMICS

- A test of the theory of reasoned action at the group level of analysis [AD-A273965] p 139 N94-25897

## GUINEA PIGS

- Interaction of tacrine at M(1) and M(2) cholinergic receptors in guinea pig brain p 129 N94-24294

## H

### HABITABILITY

- Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185  
First lunar outpost p 154 N94-25694

### HABITATS

- Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681  
Design and development of the second generation Mars Habitat p 154 N94-25693  
First lunar outpost p 154 N94-25694

### HAND (ANATOMY)

- Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956

### HANDBOOKS

- Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830

### HEAD DOWN TILT

- Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781] p 133 N94-26093

### HEAD MOVEMENT

- Predictive head movement tracking using innovations generated by Kalman filters [ISBN-0-315-83371-8] p 137 N94-24467

### HEAD-UP DISPLAYS

- Cockpit/NVG visual integration issues p 142 N94-23983

### HEART

- EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

### HEART FUNCTION

- EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

### HEATING EQUIPMENT

- Rewarming methodologies in the field [AD-A274744] p 136 N94-26173

### HELICOPTERS

- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

### HELMET MOUNTED DISPLAYS

- A simulation system for Space Station extravehicular activity p 144 N94-24192

### HEMODYNAMIC RESPONSES

- Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378

### HEMODYNAMICS

- EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909  
Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098

### HIGH RESOLUTION

- Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970

### HORMONE METABOLISMS

- Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082] p 129 N94-24124

### HUMAN BODY

- Quantitative assessment of human motion using video motion analysis p 146 N94-24203  
Development of biomechanical models for human factors evaluations p 146 N94-24205  
Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

### HUMAN CENTRIFUGES

- Artificial gravity in space flight [AD-A273420] p 134 N94-24928

### HUMAN FACTORS ENGINEERING

- Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936

- Reducing video frame rate increases remote optimal focus time  
[NASA-TM-104018] p 140 N94-23970
- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976
- Crew interface analysis: Selected articles on space human factors research, 1987 - 1991  
[NASA-TM-104756] p 142 N94-24185
- Designers' models of the human-computer interface  
p 143 N94-24188
- The use of analytical models in human-computer interface design  
p 143 N94-24190
- Using computer graphics to design Space Station Freedom viewing  
p 144 N94-24191
- Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data  
p 144 N94-24193
- Previous experience in manned space flight: A survey of human factors lessons learned  
p 144 N94-24196
- Hand controller commonality evaluation process  
p 145 N94-24197
- Programmable display pushbuttons on the Space Station's telerobot control panel  
p 145 N94-24198
- Simulation of the human-telerobot interface on the Space Station  
p 146 N94-24202
- Development of biomechanical models for human factors evaluations  
p 146 N94-24205
- Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study  
p 147 N94-24206
- NASA project 1: Full-body dynamometer  
[NASA-CR-195507] p 148 N94-24331
- Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667
- Design of a recumbent seating system  
[NASA-CR-195503] p 148 N94-24786
- Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation  
[DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- A white paper: NASA virtual environment research, applications, and technology  
[NASA-TM-109682] p 138 N94-24855
- Conceptual design of an astronaut hand anthropometry device  
[NASA-CR-195490] p 149 N94-24956
- A simulation study of control and display requirements for zero-experience general aviation pilots  
p 149 N94-25102
- Creation of prototype aircrew protection equipment based on face anthropometry  
[AD-A273865] p 153 N94-25611
- Variable speed controller  
p 153 N94-25678
- Design and development of the second generation Mars Habitat  
p 154 N94-25693
- Pax: A permanent base for human habitation of Mars  
p 154 N94-25706
- The effect of platform motion on human energy expenditure during walking. An exploratory experiment  
[AD-A273760] p 155 N94-25724
- Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory  
[DOT/FAA/AM-94/5] p 155 N94-26136
- HUMAN PERFORMANCE**
- Crew interface analysis: Selected articles on space human factors research, 1987 - 1991  
[NASA-TM-104756] p 142 N94-24185
- Quantitative assessment of human motion using video motion analysis  
p 146 N94-24203
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations  
p 146 N94-24204
- Development of biomechanical models for human factors evaluations  
p 146 N94-24205
- Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study  
p 147 N94-24206
- Pilot evaluation system  
p 137 N94-24266
- Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences  
p 150 N94-25354
- A test of the theory of reasoned action at the group level of analysis  
[AD-A273965] p 139 N94-25897
- Effects of methamphetamine on vigilance and tracking during extended wakefulness  
[AD-A274896] p 136 N94-26179
- HUMAN REACTIONS**
- Automated system function allocation and display format: Task information processing requirements  
p 143 N94-24189
- HUMAN RELATIONS**
- A test of the theory of reasoned action at the group level of analysis  
[AD-A273965] p 139 N94-25897
- HUMAN-COMPUTER INTERFACE**
- EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909
- HUMIDITY**
- Rewarming methodologies in the field  
[AD-A274744] p 136 N94-26173
- HYPOTENSION**
- Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight  
p 135 N94-25378
- HYPOTHERMIA**
- Rewarming methodologies in the field  
[AD-A274744] p 136 N94-26173
- HYPOXIA**
- Physiological protection for aircrew at high altitudes: A review of the literature  
[DCIEM-93-13] p 142 N94-24114
- ILLUMINATING**
- Evaluation of visual acuity with Gen 3 night vision goggles  
[NASA-TM-108792] p 140 N94-23974
- Illumination requirements for operating a space remote manipulator  
p 144 N94-24195
- ILLUSIONS**
- Night vision goggle illusions and visual training  
p 142 N94-23984
- IMAGE ANALYSIS**
- A model-based approach for detection of objects in low resolution passive-millimeter wave images  
p 151 N94-25507
- IMAGE ENHANCEMENT**
- Engineering workstation: Sensor modeling  
p 151 N94-25500
- Image fusion  
p 151 N94-25501
- IMAGE INTENSIFIERS**
- Evaluation of visual acuity with Gen 3 night vision goggles  
[NASA-TM-108792] p 140 N94-23974
- Night vision devices and characteristics  
p 141 N94-23982
- Night vision goggle illusions and visual training  
p 142 N94-23984
- IMAGE MOTION COMPENSATION**
- Multiple-camera/motion stereoscopy for range estimation in helicopter flight  
p 151 N94-25505
- IMAGE PROCESSING**
- Proceedings of the Workshop on Augmented Visual Display (AVID) Research  
[NASA-CP-10128] p 151 N94-25490
- Engineering workstation: Sensor modeling  
p 151 N94-25500
- Image fusion  
p 151 N94-25501
- A model-based approach for detection of objects in low resolution passive-millimeter wave images  
p 151 N94-25507
- Image processing for flight crew enhanced situation awareness  
p 152 N94-25508
- IMAGE RECONSTRUCTION**
- Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications  
p 152 N94-25512
- IMAGE RESOLUTION**
- Night vision devices and characteristics  
p 141 N94-23982
- Evaluation of image quality  
p 153 N94-25514
- IMAGES**
- Mental images  
p 137 N94-23980
- IMAGING TECHNIQUES**
- Conceptual design of an astronaut hand anthropometry device  
[NASA-CR-195490] p 149 N94-24956
- Synthetic vision system flight test results and lessons learned  
p 139 N94-25492
- IMIDES**
- The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811
- IMPLANTATION**
- The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation  
[AD-A274086] p 136 N94-25943
- INCINERATORS**
- Investigating pyrolysis/incineration as a method of resource recovery from solid waste  
p 151 N94-25375
- INDOOR AIR POLLUTION**
- Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2  
[NASA-CR-193883] p 129 N94-24310
- INFERENCE**
- Developing realistic cooperative behaviors for autonomous agents in air combat simulation  
[AD-A274077] p 139 N94-25774
- INFORMATION FLOW**
- Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom  
[NASA-CR-195508] p 149 N94-24835
- INFORMATION PROCESSING (BIOLOGY)**
- Investigation of time and intensity effects in operator workload and performance  
[CTN-94-60927] p 142 N94-24171
- Process and representation in graphical displays  
p 143 N94-24187
- Automated system function allocation and display format: Task information processing requirements  
p 143 N94-24189
- INFORMATION SYSTEMS**
- Spacecraft crew procedures from paper to computers  
p 143 N94-24186
- A simulation system for Space Station extravehicular activity  
p 144 N94-24192
- A biological survey for the nation  
[LC-93-85920] p 130 N94-24704
- INFRARED RADIATION**
- Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data  
p 144 N94-24193
- INFRARED SPECTROSCOPY**
- Non-invasive optical detection of glucose in cell culture nutrient medium  
p 131 N94-25357
- INHIBITORS**
- Evaluation of ovostatin and ovostatin assay  
p 130 N94-24437
- The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811
- INJECTION**
- Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption  
[FOA-B-40418-4.4] p 129 N94-24290
- ION SELECTIVE ELECTRODES**
- Bioregenerative life support systems for microgravity  
[NASA-CR-195516] p 131 N94-24810
- IONS**
- Bioregenerative life support systems for microgravity  
[NASA-CR-195516] p 131 N94-24810
- K**
- KALMAN FILTERS**
- Predictive head movement tracking using innovations generated by Kalman filters  
[ISBN-0-315-83371-8] p 137 N94-24467
- Multiple-camera/motion stereoscopy for range estimation in helicopter flight  
p 151 N94-25505
- KNOWLEDGE BASED SYSTEMS**
- Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES  
p 140 N94-23936
- Developing realistic cooperative behaviors for autonomous agents in air combat simulation  
[AD-A274077] p 139 N94-25774
- L**
- LANDING AIDS**
- A model-based approach for detection of objects in low resolution passive-millimeter wave images  
p 151 N94-25507
- Image processing for flight crew enhanced situation awareness  
p 152 N94-25508
- LASER APPLICATIONS**
- Conceptual design of a device to measure hand swelling in a micro-gravity environment  
[NASA-CR-195509] p 147 N94-24330
- Non-invasive optical detection of glucose in cell culture nutrient medium  
p 131 N94-25357
- LAYOUTS**
- Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation  
[DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- LECTURES**
- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976
- LIFE SUPPORT SYSTEMS**
- Bioregenerative system components for microgravity  
p 132 N94-25673
- Enabler operator station  
p 153 N94-25679
- Automation of closed environments in space for human comfort and safety  
p 154 N94-25684
- Design and development of the second generation Mars Habitat  
p 154 N94-25693
- LIGHT SCATTERING**
- Measuring the dynamics of structural changes in biological macromolecules from light scattering data  
p 130 N94-24426

## LIGHTING EQUIPMENT

### LIGHTING EQUIPMENT

Cockpit/NVG visual integration issues p 142 N94-23983

#### LIVER

In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688

#### LOADS (FORCES)

Loading, electromyograph, and motion during exercise p 134 N94-25359  
Loading, electromyograph, and motion during exercise p 135 N94-25380

#### LONG DURATION SPACE FLIGHT

Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667

#### LONG TERM EFFECTS

Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368

#### LUMINANCE

Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974  
Night vision devices and characteristics p 141 N94-23982

Luminance-brightness mapping: The missing decades [ETN-94-95351] p 138 N94-25298

#### LUMINESCENCE

Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791

#### LUNAR BASES

First lunar outpost p 154 N94-25694  
The 1991-1992 project summaries p 154 N94-25698

#### LUNAR ENVIRONMENT

First lunar outpost p 154 N94-25694

#### LUNAR GRAVITATION

First lunar outpost p 154 N94-25694

#### LUNAR SURFACE VEHICLES

Enabler operator station p 153 N94-25679  
Dust control for Enabler p 153 N94-25680

## M

### MACHINERY

Variable speed controller p 153 N94-25678

### MAINTENANCE

Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory [DOT/FAA/AM-94/5] p 155 N94-26136

### MALES

Thermoregulatory effects of caffeine ingestion during rest and exercise in men [NASA-TM-108783] p 133 N94-26210

### MAN MACHINE SYSTEMS

Intelligent tutoring and aiding in satellite ground control p 140 N94-23929  
Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198  
Simulation of the human-telerobot interface on the Space Station p 146 N94-24202  
Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications p 152 N94-25512  
Quality metrics for sensor images p 152 N94-25513

### MAN-COMPUTER INTERFACE

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185  
Process and representation in graphical displays p 143 N94-24187  
Designers' models of the human-computer interface p 143 N94-24188  
Automated system function allocation and display format: Task information processing requirements p 143 N94-24189  
The use of analytical models in human-computer interface design p 143 N94-24190

### MANIPULATORS

Illumination requirements for operating a space remote manipulator p 144 N94-24195  
Robotics in a controlled, ecological life support system p 150 N94-25371

### MANNED MARS MISSIONS

Pax: A permanent base for human habitation of Mars p 154 N94-25706

### MANNED REENTRY

Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667

### MANNED SPACE FLIGHT

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185

Previous experience in manned space flight: A survey of human factors lessons learned p 144 N94-24196

### MANUAL CONTROL

Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970  
Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199

### MARS ENVIRONMENT

First lunar outpost p 154 N94-25694

### MARS SURFACE

Design and development of the second generation Mars Habitat p 154 N94-25693

### MASKING

Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

### MATERIALS HANDLING

Robotics in a controlled, ecological life support system p 150 N94-25371

### MATHEMATICAL MODELS

The use of analytical models in human-computer interface design p 143 N94-24190  
An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146  
Loading, electromyograph, and motion during exercise p 134 N94-25359  
Quality metrics for sensor images p 152 N94-25513

### MAXIMUM LIKELIHOOD ESTIMATES

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

### MEASURING INSTRUMENTS

Bioregenerative life support systems for microgravity [NASA-CR-195516] p 131 N94-24810  
Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956

### MECHANICAL ENGINEERING

The 1991-1992 project summaries p 154 N94-25698

### MEDICAL SERVICES

Annual research progress report, fiscal year 1992. Volume 2: Department of Clinical Investigation [AD-A273584] p 134 N94-24945

### MENTAL PERFORMANCE

Mental images p 137 N94-23980  
Investigation of time and intensity effects in operator workload and performance [CTN-94-60927] p 142 N94-24171  
Automated system function allocation and display format: Task information processing requirements p 143 N94-24189  
EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171] p 138 N94-24799

### METABOLISM

In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688

### METHAMPHETAMINE

Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

### MICROBIOLOGY

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310  
Microbial biofilm formation and its consequences for the CELSS program [NASA-CR-195146] p 148 N94-24706

### MICROFIBERS

Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290

### MICROGRAVITY

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785] p 133 N94-24102  
Conceptual design of a device to measure hand swelling in a micro-gravity environment [NASA-CR-195509] p 147 N94-24330  
NASA project J.: Full-body dynamometer [NASA-CR-195507] p 148 N94-24331  
Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426  
Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667  
Artificial gravity in space flight [AD-A273420] p 134 N94-24928  
The role of visual context in manual target localization p 138 N94-25351

Loading, electromyograph, and motion during exercise p 134 N94-25359

Development of a model to assess orthostatic responses p 135 N94-25376  
Autonomous support for microorganism research in space p 132 N94-25672  
Bioregenerative system components for microgravity p 132 N94-25673  
First lunar outpost p 154 N94-25694

### MICROORGANISMS

Microbial biofilm formation and its consequences for the CELSS program [NASA-CR-195146] p 148 N94-24706  
Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791  
Autonomous support for microorganism research in space p 132 N94-25672

### MICROWAVE IMAGERY

A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507

### MILITARY HELICOPTERS

Night operations p 141 N94-23977

### MILITARY OPERATIONS

Night operations p 141 N94-23977  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119

### MILITARY TECHNOLOGY

Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119

### MILLIMETER WAVES

A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507

### MIR SPACE STATION

Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667

### MISSION PLANNING

First lunar outpost p 154 N94-25694  
Pax: A permanent base for human habitation of Mars p 154 N94-25706

### MODELS

Designers' models of the human-computer interface p 143 N94-24188

### MODULES

Design and development of the second generation Mars Habitat p 154 N94-25693

### MOLECULAR STRUCTURE

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

### MOLECULAR WEIGHT

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

### MOLECULES

Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

### MOTION PERCEPTION

Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979  
Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510

### MOTION SICKNESS

Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979  
Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227

### MOTION SIMULATION

Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

### MOTION SIMULATORS

The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724

### MULTIPLEXING

The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation [AD-A274086] p 136 N94-25943

### MULTISENSOR APPLICATIONS

Multi-sensoral approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981

### MUSCLES

Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082] p 129 N94-24124  
Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290

## SUBJECT INDEX

## SUBJECT INDEX

- Loading, electromyograph, and motion during exercise  
p 134 N94-25359
- Loading, electromyograph, and motion during exercise  
p 135 N94-25380

### MUSCULAR STRENGTH

- NASA project 1: Full-body dynamometer  
[NASA-CR-195507] p 148 N94-24331

### MUSCULOSKELETAL SYSTEM

- Skeletal muscle metabolism in hypokinetic rats  
[NASA-CR-195082] p 129 N94-24124

## N

### NAP-OF-THE-EARTH NAVIGATION

- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

### NEURAL NETS

- The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation  
[AD-A274086] p 136 N94-25943

### NIGHT FLIGHTS (AIRCRAFT)

- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976

### NIGHT VISION

- Evaluation of visual acuity with Gen 3 night vision goggles  
[NASA-TM-108792] p 140 N94-23974
- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976
- Night operations p 141 N94-23977
- Physical aspects of the visual stimulus p 141 N94-23978

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979
- Mental images p 137 N94-23980
- Multi-sensorial approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981
- Night vision devices and characteristics p 141 N94-23982

- Cockpit/NVG visual integration issues p 142 N94-23983

- Night vision goggle illusions and visual training p 142 N94-23984

### NONINTRUSIVE MEASUREMENT

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### NUMERICAL CONTROL

- Bioregenerative life support systems for microgravity  
[NASA-CR-195516] p 131 N94-24810

### NUTRIENTS

- Microbial biofilm formation and its consequences for the CELSS program  
[NASA-CR-195146] p 148 N94-24706

## O

### ON-LINE SYSTEMS

- Intelligent tutoring and aiding in satellite ground control p 140 N94-23929

### OPERATOR PERFORMANCE

- Investigation of time and intensity effects in operator workload and performance  
[CTN-94-60927] p 142 N94-24171

### OPERATORS (PERSONNEL)

- Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE)  
p 136 N94-23933

### OPTICAL FLOW (IMAGE ANALYSIS)

- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510
- Optical information in landing scenes p 152 N94-25511

### OPTICAL MEASUREMENT

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### OPTICAL MEASURING INSTRUMENTS

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### OPTICAL PROPERTIES

- Night vision devices and characteristics p 141 N94-23982
- Cockpit/NVG visual integration issues p 142 N94-23983

### OPTOELECTRONIC DEVICES

- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976

### OPTOMETRY

- Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

### ORBITAL SERVICING

- Illumination requirements for operating a space remote manipulator p 144 N94-24195

### ORBITAL WORKERS

- A simulation system for Space Station extravehicular activity p 144 N94-24192

### ORGANIZATIONS

- Towards a new radiation protection organization  
[FOA-C-40304-4.3] p 147 N94-24292

### ORTHOSTATIC TOLERANCE

- Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews  
[NASA-TM-108785] p 133 N94-24102
- Development of a model to assess orthostatic responses p 135 N94-25376
- Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378
- Intermittent gravity: How much, how often, how long?  
[NASA-TM-108800] p 155 N94-26098

### OXYGEN

- A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure  
[AD-A273488] p 134 N94-24950

### OXYGEN CONSUMPTION

- Intermittent gravity: How much, how often, how long?  
[NASA-TM-108800] p 155 N94-26098

### OXYGEN MASKS

- Creation of prototype aircrew protection equipment based on face anthropometry  
[AD-A273865] p 153 N94-25611

## P

### PARTICULATE SAMPLING

- Bioregenerative life support systems for microgravity  
[NASA-CR-195516] p 131 N94-24810

### PATTERN RECOGNITION

- Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363
- An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369

### PEPTIDES

- The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811

### PERCEPTION

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt?  
[NASA-CR-188256] p 134 N94-24227
- Perceptions of organizational support and affectivity as predictors of job satisfaction  
[DOT/FAA/AM-94/2] p 139 N94-25442

### PERCEPTUAL ERRORS

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979
- Night vision goggle illusions and visual training p 142 N94-23984
- Mechanisms of eye-hand coordination  
[AD-A273687] p 139 N94-25437

### PERFORMANCE PREDICTION

- Investigation of time and intensity effects in operator workload and performance  
[CTN-94-60927] p 142 N94-24171
- Pilot evaluation system p 137 N94-24266

### PERFORMANCE TESTS

- The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201
- Design and simulation of EVA tools for first servicing mission of HST  
[NASA-CR-194784] p 149 N94-24857

- Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences p 150 N94-25354
- Evaluation of image quality p 153 N94-25514

- A test of the theory of reasoned action at the group level of analysis  
[AD-A273965] p 139 N94-25897

- Rewarming methodologies in the field  
[AD-A274744] p 136 N94-26173

### PHOTOGRAMMETRY

- Quantitative assessment of human motion using video motion analysis p 146 N94-24203
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

### PHYSICAL EXERCISE

- NASA project 1: Full-body dynamometer  
[NASA-CR-195507] p 148 N94-24331
- Loading, electromyograph, and motion during exercise p 134 N94-25359

- The effect of platform motion on human energy expenditure during walking. An exploratory experiment  
[AD-A273760] p 155 N94-25724

## PROTEIN METABOLISM

- Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt  
[NASA-TM-108781] p 133 N94-26093

- Thermoregulatory effects of caffeine ingestion during rest and exercise in men  
[NASA-TM-108783] p 133 N94-26210

### PHYSIOLOGICAL EFFECTS

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt?  
[NASA-CR-188256] p 134 N94-24227

### PHYSIOLOGICAL RESPONSES

- Physiological protection for aircrew at high altitudes: A review of the literature  
[DCIEM-93-13] p 142 N94-24114

- The role of visual context in manual target localization p 138 N94-25351

- The effect of platform motion on human energy expenditure during walking. An exploratory experiment  
[AD-A273760] p 155 N94-25724

- Thermoregulatory effects of caffeine ingestion during rest and exercise in men  
[NASA-TM-108783] p 133 N94-26210

### PHYSIOLOGICAL TESTS

- Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378

- Mechanisms of eye-hand coordination  
[AD-A273687] p 139 N94-25437

- Effects of methamphetamine on vigilance and tracking during extended wakefulness  
[AD-A274896] p 136 N94-26179

### PHYSIOLOGY

- Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976

- Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data p 144 N94-24193

### PILOT PERFORMANCE

- Pilot evaluation system p 137 N94-24266
- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510

- Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications p 152 N94-25512
- Quality metrics for sensor images p 152 N94-25513

### PILOT TRAINING

- Pilot evaluation system p 137 N94-24266
- A simulation study of control and display requirements for zero-experience general aviation pilots p 149 N94-25102

### PLANETARY BASES

- Pax: A permanent base for human habitation of Mars p 154 N94-25706

### POPULATIONS

- An exploratory stochastic model for toxic effects on cells  
[AD-A273438] p 131 N94-25146

### PORTABLE EQUIPMENT

- Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681

### POSITION (LOCATION)

- The role of visual context in manual target localization p 138 N94-25351

- Mechanisms of eye-hand coordination  
[AD-A273687] p 139 N94-25437

### PREDICTION ANALYSIS TECHNIQUES

- Predictive head movement tracking using innovations generated by Kalman filters  
[ISBN-0-315-83371-8] p 137 N94-24467

### PRESSURE REGULATORS

- Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human + Gz research  
[DCIEM-93-05] p 147 N94-24299

### PRODUCT DEVELOPMENT

- Training: Plugging the information gaps p 136 N94-23934

### PROGRAMMERS

- Designers' models of the human-computer interface p 143 N94-24188

### PROSTHETIC DEVICES

- Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

### PROTEASE

- Evaluation of ovostatin and ovostatin assay p 130 N94-24437

### PROTECTIVE CLOTHING

- Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew  
[DCIEM-93-06] p 142 N94-24119

### PROTEIN METABOLISM

- Skeletal muscle metabolism in hypokinetic rats  
[NASA-CR-195082] p 129 N94-24124

## PROTEINS

### PROTEINS

- Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290
- Evaluation of ovostatin and ovostatin assay p 130 N94-24437
- In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688
- PSYCHOLOGICAL EFFECTS**
- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227
- PSYCHOLOGY**
- Pacing visual attention: Temporal structure effects [AD-A273859] p 140 N94-25965
- PSYCHOMETRICS**
- EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171] p 138 N94-24799
- PSYCHOPHYSICS**
- Physical aspects of the visual stimulus p 141 N94-23978
- Luminance-brightness mapping: The missing decades [ETN-94-95351] p 138 N94-25298
- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510
- PSYCHOPHYSIOLOGY**
- EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171] p 138 N94-24799
- PYROLYSIS**
- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

## R

### RADAR

- Image processing for flight crew enhanced situation awareness p 152 N94-25508

### RADAR IMAGERY

- Synthetic vision system flight test results and lessons learned p 139 N94-25492

### RADIANCE

- Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974

### RADIANT FLUX DENSITY

- Physical aspects of the visual stimulus p 141 N94-23978

### RADIATION PROTECTION

- Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

### RADIATION SHIELDING

- The 1991-1992 project summaries p 154 N94-25698

### RANGEFINDING

- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

### RATS

- Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082] p 129 N94-24124
- In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688

### REACTION TIME

- Automated system function allocation and display format: Task information processing requirements p 143 N94-24189
- Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

### REACTOR DESIGN

- Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368

### REAL TIME OPERATION

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### REGENERATION (PHYSIOLOGY)

- Bioregenerative system components for microgravity p 132 N94-25673

### REMOTE CONTROL

- Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185

### REMOTE MANIPULATOR SYSTEM

- Illumination requirements for operating a space remote manipulator p 144 N94-24195
- Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198
- The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201

### RESEARCH

- Index to FAA Office of Aviation Medicine Reports: 1961 through 1993 [DOT/FAA/AM-94/1] p 133 N94-24093
- Proceedings of the symposium on current concepts and approaches on animal test alternatives [AD-A273926] p 132 N94-25593

### RESOURCES MANAGEMENT

- A biological survey for the nation [LC-93-85920] p 130 N94-24704
- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

### REST

- Thermoregulatory effects of caffeine ingestion during rest and exercise in men [NASA-TM-108783] p 133 N94-26210

### RETINA

- Physical aspects of the visual stimulus p 141 N94-23978

### RISK

- In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688
- A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

### ROBOT CONTROL

- Development of a force feedback anthropomorphic teleoperation input device for control of robot hands [NASA-CR-195109] p 147 N94-24329

### ROBOT SENSORS

- An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369

### ROBOTICS

- An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369
- Robotics in a controlled, ecological life support system p 150 N94-25371

### ROVING VEHICLES

- The 1991-1992 project summaries p 154 N94-25698

## S

### SAFETY DEVICES

- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204
- The 1991-1992 project summaries p 154 N94-25698

### SATELLITE CONTROL

- Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933

### SCENE ANALYSIS

- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510
- Optical information in landing scenes p 152 N94-25511

### SCIENTIFIC VISUALIZATION

- A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109682] p 138 N94-24855

### SEA WATER

- Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791

### SEATS

- Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786

### SEMICONDUCTORS (MATERIALS)

- The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation [AD-A274086] p 136 N94-25943

### SENSORY MOTOR PERFORMANCE

- The role of visual context in manual target localization p 138 N94-25351
- Mechanisms of eye-hand coordination [AD-A273687] p 139 N94-25437

### SENSORY DISCRIMINATION

- Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

### SENSORY PERCEPTION

- A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109682] p 138 N94-24855

### SERUMS

- Non-invasive optical detection of glucose in cell culture nutrient medium p 131 N94-25357

### SEWING

- Variable speed controller p 153 N94-25678

### SHAPES

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979
- Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

### SHELTERS

- Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681
- Pax: A permanent base for human habitation of Mars p 154 N94-25706

### SHOCK ABSORBERS

- Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786

### SIGNAL DETECTION

- Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

### SIGNAL DISTORTION

- Night vision devices and characteristics p 141 N94-23982

### SLEEP DEPRIVATION

- Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

### SOFTWARE ENGINEERING

- Designers' models of the human-computer interface p 143 N94-24188

### SOLID WASTES

- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

### SPACE ADAPTATION SYNDROME

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227

### SPACE FLIGHT

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227

### SPACE FLIGHT STRESS

- Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt? [NASA-CR-188256] p 134 N94-24227

### SPACE FLIGHT

- Artificial gravity in space flight [AD-A273420] p 134 N94-24928

### SPACE HABITATS

- Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185
- Automation of closed environments in space for human comfort and safety p 154 N94-25684

### SPACE MAINTENANCE

- A simulation system for Space Station extravehicular activity p 144 N94-24192
- Design and simulation of EVA tools for first servicing mission of HST [NASA-CR-194784] p 149 N94-24857

### SPACE MISSIONS

- Use of infrared telemetry as part of a nonintrusive inflight data collection system to collect human factors data p 144 N94-24193

### SPACE PERCEPTION

- Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979
- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510

### SPACE STATION FREEDOM

- Spacecraft crew procedures from paper to computers p 143 N94-24186

- Using computer graphics to design Space Station Freedom viewing p 144 N94-24191

- A simulation system for Space Station extravehicular activity p 144 N94-24192

- Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

- Simulation of the human-telerobot interface on the Space Station p 146 N94-24202

- Automation of closed environments in space for human comfort and safety p 154 N94-25684

### SPACE SUITS

- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

### SPACE TOOLS

- Design and simulation of EVA tools for first servicing mission of HST [NASA-CR-194784] p 149 N94-24857

### SPACEBORNE EXPERIMENTS

- Autonomous support for microorganism research in space p 132 N94-25672

### SPACECRAFT CABINS

- First lunar outpost p 154 N94-25694

**SPACECRAFT CONTAMINATION**

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310

**SPACECRAFT DESIGN**

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185

**SPACECRAFT LAUNCHING**

Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

**SPACECRAFT MAINTENANCE**

A simulation system for Space Station extravehicular activity p 144 N94-24192  
Illumination requirements for operating a space remote manipulator p 144 N94-24195

**SPACECRAFT MODULES**

First lunar outpost p 154 N94-25694

**SPACECREWS**

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185  
Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data p 144 N94-24193

Illumination requirements for operating a space remote manipulator p 144 N94-24195

Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

Development of biomechanical models for human factors evaluations p 146 N94-24205

Design and development of the second generation Mars Habitat p 154 N94-25693

First lunar outpost p 154 N94-25694

**SPACELAB**

Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310

**SPATIAL RESOLUTION**

Evaluation of image quality p 153 N94-25514

**SPEED CONTROL**

Variable speed controller p 153 N94-25678

**SPHERES**

Design and development of the second generation Mars Habitat p 154 N94-25693

**STATISTICAL ANALYSIS**

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

**STEREOSCOPY**

Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

**STIMULATION**

Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

**STOCHASTIC PROCESSES**

An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146

**STROKE VOLUME**

Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378

**STRUCTURAL DESIGN**

Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786

**STRUTS**

Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786

**SUPPORT SYSTEMS**

Multi-sensoral approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981

**SURVEYS**

A biological survey for the nation [LC-93-85920] p 130 N94-24704  
Perceptions of organizational support and affectivity as predictors of job satisfaction [DOT/FAA/AM-94/2] p 139 N94-25442

**SWELLING**

Conceptual design of a device to measure hand swelling in a micro-gravity environment [NASA-CR-195509] p 147 N94-24330

**SYMBIOSIS**

Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791

**SYSTEMS ENGINEERING**

Training: Plugging the information gaps p 136 N94-23934

**SYSTEMS INTEGRATION**

Cockpit/NVG visual integration issues p 142 N94-23983

**SYSTEMS SIMULATION**

A simulation system for Space Station extravehicular activity p 144 N94-24192

**SYSTOLIC PRESSURE**

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-109875] p 133 N94-24102

**T****TACTILE DISCRIMINATION**

Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences p 150 N94-25354

**TASK COMPLEXITY**

Pilot evaluation system p 137 N94-24266

**TASKS**

The role of visual context in manual target localization p 138 N94-25351

**TECHNOLOGY UTILIZATION**

A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109882] p 138 N94-24855

**TELEMETRY**

Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data p 144 N94-24193

**TELEOPERATORS**

Crew interface analysis: Selected articles on space human factors research, 1987 - 1991 [NASA-TM-104756] p 142 N94-24185

Hand controller commonality evaluation process p 145 N94-24197

Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198

Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201

Development of a force feedback anthropomorphic teleoperation input device for control of robot hands [NASA-CR-195109] p 147 N94-24329

**TELEROBOTICS**

Hand controller commonality evaluation process p 145 N94-24197

Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198

Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199

Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201

Simulation of the human-telerobot interface on the Space Station p 146 N94-24202

**TELEVISION SYSTEMS**

Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970

**TEMPERATURE CONTROL**

The 1991-1992 project summaries p 154 N94-25698

**TEMPORAL RESOLUTION**

Evaluation of image quality p 153 N94-25514

**TETHERLINES**

The 1991-1992 project summaries p 154 N94-25698

**THERAPY**

Rewarming methodologies in the field [AD-A274744] p 136 N94-26173

**THERMOREGULATION**

Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781] p 133 N94-26093

Thermoregulatory effects of caffeine ingestion during rest and exercise in men [NASA-TM-108783] p 133 N94-26210

**THREE DIMENSIONAL MODELS**

Conceptual design of a device to measure hand swelling in a micro-gravity environment [NASA-CR-195509] p 147 N94-24330

**THREE DIMENSIONAL MOTION**

Quantitative assessment of human motion using video motion analysis p 146 N94-24203

**TIME DEPENDENCE**

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

**TISSUES (BIOLOGY)**

Autonomous support for microorganism research in space p 132 N94-25672

**TORQUE**

Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206

**TOUCH**

Mechanisms of eye-hand coordination [AD-A273687] p 139 N94-25437

**TOXICITY**

In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146

**TOXICOLOGY**

Proceedings of the symposium on current concepts and approaches on animal test alternatives [AD-A273926] p 132 N94-25593

**TOXINS AND ANTITOXINS**

An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146

**TRACKING (POSITION)**

Predictive head movement tracking using innovations generated by Kalman filters [ISBN-0-315-83371-8] p 137 N94-24467

**TRACKING FILTERS**

Predictive head movement tracking using innovations generated by Kalman filters [ISBN-0-315-83371-8] p 137 N94-24467

**TRAINING DEVICES**

Intelligent tutoring and aiding in satellite ground control p 140 N94-23929

**TRANSMISSION RATE (COMMUNICATIONS)**

Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970

**TRANSPORT AIRCRAFT**

Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830

**TUMORS**

Annual research progress report, fiscal year 1992. Volume 2: Department of Clinical Investigation [AD-A273584] p 134 N94-24945

**U****ULTRASONIC SCANNERS**

Conceptual design of a device to measure hand swelling in a micro-gravity environment [NASA-CR-195509] p 147 N94-24330

**UNIVERSITY PROGRAM**

Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

**USER MANUALS (COMPUTER PROGRAMS)**

EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

**USER REQUIREMENTS**

Training: Plugging the information gaps p 136 N94-23934

The use of analytical models in human-computer interface design p 143 N94-24190

**V****VEGETATION GROWTH**

Microbial biofilm formation and its consequences for the CELSS program [NASA-CR-195146] p 148 N94-24706

Bioregenerative system components for microgravity p 132 N94-25673

**VESTIBULES**

Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979

The role of visual context in manual target localization p 138 N94-25351

**VIBRATION ISOLATORS**

The 1991-1992 project summaries p 154 N94-25698

**VIDEO EQUIPMENT**

Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956

**VIDEO SIGNALS**

Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970



## VIEWING

## VIEWING

- Using computer graphics to design Space Station Freedom viewing p 144 N94-24191
- Illumination requirements for operating a space remote manipulator p 144 N94-24195

## VIRTUAL REALITY

- A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109682] p 138 N94-24855

## VISIBILITY

- A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507

## VISION

- Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363

## VISUAL ACUITY

- Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974
- Cockpit/NVG visual integration issues p 142 N94-23983

## VISUAL CONTROL

- The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201

## VISUAL DISCRIMINATION

- Quality metrics for sensor images p 152 N94-25513

## VISUAL FIELDS

- Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

## VISUAL PERCEPTION

- Visual Problems in Night Operations [AGARD-LS-187] p 141 N94-23976
- Multi-sensoral approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981
- Cockpit/NVG visual integration issues p 142 N94-23983
- Night vision goggle illusions and visual training p 142 N94-23984
- Luminance-brightness mapping: The missing decades [ETN-94-95351] p 138 N94-25298
- Synthetic vision system flight test results and lessons learned p 139 N94-25492
- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510
- Optical information in landing scenes p 152 N94-25511
- Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871
- The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation [AD-A274086] p 136 N94-25943
- Pacing visual attention: Temporal structure effects [AD-A273859] p 140 N94-25965

## VISUAL STIMULI

- Physical aspects of the visual stimulus p 141 N94-23978

## VISUAL TASKS

- Automated system function allocation and display format: Task information processing requirements p 143 N94-24189

## VOICE CONTROL

- Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199

## W

## WAKEFULNESS

- Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

## WALKING

- The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724

## WARFARE

- Night operations p 141 N94-23977

## WARNING SYSTEMS

- Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

## WASTE ENERGY UTILIZATION

- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

## WASTE TREATMENT

- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

## WASTE UTILIZATION

- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

## WATER IMMERSION

- Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt [NASA-TM-108781] p 133 N94-26093

## WATER QUALITY

- A chemical sensor and biosensor based totally automated water quality monitor for extended space flight: Step 1 p 148 N94-24447

## WEIGHTLESSNESS

- Artificial gravity in space flight [AD-A273420] p 134 N94-24928
- Loading, electromyograph, and motion during exercise p 134 N94-25359
- Development of a model to assess orthostatic responses p 135 N94-25376

## WEIGHTLESSNESS SIMULATION

- Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368

## WINDSHIELDS

- Cockpit/NVG visual integration issues p 142 N94-23983

## WORKLOADS (PSYCHOPHYSIOLOGY)

- Investigation of time and intensity effects in operator workload and performance [CTN-94-60927] p 142 N94-24171
- Pilot evaluation system p 137 N94-24266
- Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505
- Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077] p 139 N94-25774

## WORKSTATIONS

- Engineering workstation: Sensor modeling p 151 N94-25500

## X

## X RAY ANALYSIS

- Evaluation of ovostatin and ovostatin assay p 130 N94-24437

## Y

## YEAST

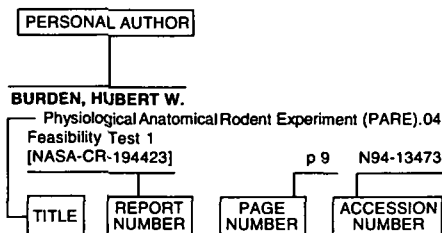
- Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368

# PERSONAL AUTHOR INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 388)

May 1994

## Typical Personal Author Index Listing



Listings in this index are arranged alphabetically by personal author. The title of the document is used to provide a brief description of the subject matter. The report number helps to indicate the type of document (e.g., NASA report, translation, NASA contractor report). The page and accession numbers are located beneath and to the right of the title. Under any one author's name the accession numbers are arranged in sequence.

## A

- ADAM, SUSAN C.**  
Hand controller commonality evaluation process  
p 145 N94-24197
- AHUMADA, AL**  
Quality metrics for sensor images p 152 N94-25513
- ALVAREZ, OMAR**  
First lunar outpost p 154 N94-25694
- AMALBERTI, RENE**  
Mental images p 137 N94-23980  
Multi-sensorial approach to night flight: Perceptive and  
Cognitive limitations p 141 N94-23981
- ANDINO, AUREO F.**  
First lunar outpost p 154 N94-25694

## B

- BAGIAN, JAMES P.**  
Reach performance while wearing the Space Shuttle  
launch and entry suit during exposure to launch  
accelerations p 146 N94-24204
- BAGIAN, TANDI**  
Crew interface analysis: Selected articles on space  
human factors research, 1987 - 1991  
[NASA-TM-104756] p 142 N94-24185
- BAILEY, ANDREA**  
Enabler operator station p 153 N94-25679
- BAILIN, SIDNEY C.**  
Automating a human factors evaluation of graphical user  
interfaces for NASA applications: An update on CHIMES  
p 140 N94-23936
- BALLANTYNE, M. J.**  
Operation Friction: Development and introduction of  
personal cooling for CH124 Sea King aircrew  
[DCIEM-93-06] p 142 N94-24119
- BANKS, MARTIN S.**  
Extracting heading and temporal range from optic flow:  
Human performance issues p 152 N94-25510
- BARRY, SUSAN R.**  
The role of visual context in manual target localization  
p 138 N94-25351
- BERKLEY, WILLIAM E.**  
Night operations p 141 N94-23977  
Night vision goggle illusions and visual training  
p 142 N94-23984

- BIERSCHWALE, JOHN M.**  
Hand controller commonality evaluation process  
p 145 N94-24197
- Speech versus manual control of camera functions  
during a telerobotic task p 145 N94-24199
- Space Station Freedom coupling tasks: An evaluation  
of their telerobotic and EVA compatibility  
p 145 N94-24200
- BISHU, RAM R.**  
Investigation of hand capabilities under a variety of  
performance conditions and an attempt to explain  
performance differences p 150 N94-25354
- BLANCHARD, ROBERT E.**  
Human factors in airway facilities maintenance:  
Development of a prototype outage assessment  
inventory  
[DOT/FAA/AM-94/5] p 155 N94-26136
- BOSSI, L. L. M.**  
Operation Friction: Development and introduction of  
personal cooling for CH124 Sea King aircrew  
[DCIEM-93-06] p 142 N94-24119
- BRADLEY, ARTHUR**  
Evaluation of visual acuity with Gen 3 night vision  
goggles  
[NASA-TM-108792] p 140 N94-23974
- BREEDIN, SARAH D.**  
Designers' models of the human-computer interface  
p 143 N94-24188
- BRONKEMA, LISA**  
Investigation of hand capabilities under a variety of  
performance conditions and an attempt to explain  
performance differences p 150 N94-25354
- BROOKS, BARRY**  
Concepts and embodiment design of a reentry  
recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667
- BUICK, F.**  
Computer control of an electro-mechanical regulator for  
providing positive pressure breathing and an electronic  
G-valve for human + Gz research  
[DCIEM-93-05] p 147 N94-24299
- BURTON, RUSSELL R.**  
Artificial gravity in space flight  
[AD-A273420] p 134 N94-24928

## C

- CARPENTER, R. L.**  
An exploratory stochastic model for toxic effects on  
cells  
[AD-A273438] p 131 N94-25146
- CASTRONUOVO, M.**  
Pilot-vehicle interface handbook, chapter 19. Volume 2:  
Digital systems validation  
[DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- CHANDLER, GEORGE O.**  
Illumination requirements for operating a space remote  
manipulator p 144 N94-24195
- Previous experience in manned space flight: A survey  
of human factors lessons learned p 144 N94-24196
- CHU, ROSE W.**  
Intelligent tutoring and aiding in satellite ground  
control p 140 N94-23929
- CHUDEJ, CHRIS**  
Concepts and embodiment design of a reentry  
recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667
- CISAR, CRAIG J.**  
Thermoregulatory effects of caffeine ingestion during  
rest and exercise in men  
[NASA-TM-108783] p 133 N94-26210
- COGLEY, ALLEN C.**  
Automation of closed environments in space for human  
comfort and safety p 154 N94-25684
- COLLINS, WILLIAM E.**  
Index to FAA Office of Aviation Medicine Reports: 1961  
through 1993  
[DOT/FAA/AM-94/1] p 133 N94-24093
- COLON, JULIO A.**  
First lunar outpost p 154 N94-25694

- COLON, MYRELLE**  
First lunar outpost p 154 N94-25694
- COTE, GERALD L.**  
Non-invasive optical detection of glucose in cell culture  
nutrient medium p 131 N94-25357
- COWINGS, PATRICIA S.**  
Autogenic-feedback training: A potential treatment for  
post-flight orthostatic intolerance in aerospace crews  
[NASA-TM-108785] p 133 N94-24102
- CRAWFORD, EARNEST**  
Design and development of the second generation Mars  
Habitat p 154 N94-25693
- CROWELL, JAMES A.**  
Extracting heading and temporal range from optic flow:  
Human performance issues p 152 N94-25510
- CROYLE, SCOTT**  
Design of a recumbent seating system  
[NASA-CR-195503] p 148 N94-24786
- CZERWINSKI, MARY P.**  
Automated system function allocation and display  
format: Task information processing requirements  
p 143 N94-24189

## D

- DEHOFF, P. H.**  
Design and simulation of EVA tools for first servicing  
mission of HST  
[NASA-CR-194784] p 149 N94-24857
- DELAROSA, JOSE**  
Design of a recumbent seating system  
[NASA-CR-195503] p 148 N94-24786
- DEVADIGA, SADASHIVA**  
A model-based approach for detection of objects in low  
resolution passive-millimeter wave images  
p 151 N94-25507
- DEVANY, CHRIS**  
Concepts and embodiment design of a reentry  
recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667
- DIAZ, ALICIA**  
First lunar outpost p 154 N94-25694
- DIAZ, MANUEL F.**  
Hand controller commonality evaluation process  
p 145 N94-24197
- DUNAGAN, NANCY**  
Thermoregulatory effects of caffeine ingestion during  
rest and exercise in men  
[NASA-TM-108783] p 133 N94-26210

## E

- EDVARSON, KAY**  
Towards a new radiation protection organization  
[FOA-C-40304-4.3] p 147 N94-24292
- ERTL, ANDREW CARL**  
Plasma volume shifts and exercise thermoregulation with  
water immersion and six-degree head-down tilt  
[NASA-TM-108781] p 133 N94-26093
- ESCOBAR, XOCHIQUETZAL Y.**  
First lunar outpost p 154 N94-25694
- ESTES, CHRISTA**  
Variable speed controller p 153 N94-25678

## F

- FEITH, S.**  
Rewarming methodologies in the field  
[AD-A274744] p 136 N94-26173
- FIEBER, JOSEPH P.**  
Pax: A permanent base for human habitation of Mars  
p 154 N94-25706
- FIGUEROA, FERNANDO**  
Loading, electromyograph, and motion during exercise  
p 134 N94-25359
- FITCH, THOMAS A.**  
A test of the theory of reasoned action at the group  
level of analysis  
[AD-A273965] p 139 N94-25897

## FLEET, M. L.

- FLEET, M. L.**  
Autonomous support for microorganism research in space p 132 N94-25672
- FLEMING, TERENCE F.**  
Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200
- FLINK, INGELA**  
Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292
- FORSBERG, AAKE**  
Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290
- FOYLE, DAVID C.**  
Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications p 152 N94-25512
- FRIM, J.**  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119

## G

- GARCIA, ALBERTO**  
First lunar outpost p 154 N94-25694
- GAYER, D. P.**  
An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146
- GEORGE, DAREN**  
Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786
- GEORGIOPOULOS, APOSTOLOS P.**  
Mechanisms of eye-hand coordination [AD-A273687] p 139 N94-25437
- GILLAN, DOUGLAS J.**  
Process and representation in graphical displays p 143 N94-24187  
Designers' models of the human-computer interface p 143 N94-24188
- GLASS, K. C.**  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119
- GOLDSBERRY, BETTY S.**  
Using computer graphics to design Space Station Freedom viewing p 144 N94-24191
- GONZALEZ, ISABEL C.**  
First lunar outpost p 154 N94-25694
- GOODMAN, L. S.**  
Physiological protection for aircrew at high altitudes: A review of the literature [DCIEM-93-13] p 142 N94-24114
- GREEN, CAROL E.**  
In vitro system for studying metabolism of environmental chemicals in human cells [AD-A273427] p 130 N94-24688
- GREENISEN, MICHAEL**  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206
- GREENISEN, MICHAEL C.**  
Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204
- GREENLEAF, JOHN E.**  
Thermoregulatory effects of caffeine ingestion during rest and exercise in men [NASA-TM-108783] p 133 N94-26210
- GRIFFITH, JON**  
An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086
- GRISWOLD, SAMANTHA S.**  
Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681
- GUGERTY, LEO**  
The use of analytical models in human-computer interface design p 143 N94-24190
- GUNDO, DAN**  
An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086

## H

- HAINES, RICHARD F.**  
Reducing video frame rate increases remote optimal focus time [NASA-TM-104018] p 140 N94-23970
- HALL, JOSEPH W.**  
Auditory spectro-temporal pattern analysis [AD-A273554] p 134 N94-24865

## B-2

- HARABIN, A. L.**  
A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950
- HARRELL, BROCK**  
Design and development of the second generation Mars Habitat p 154 N94-25693
- HARRIS, RANDALL L., SR.**  
A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507
- HARRISON, L.**  
Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- HASSON, SCOTT**  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206
- HELLMAN, ROLF**  
Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292
- HESSEL, MICHAEL I., JR.**  
Bioregenerative life support systems for microgravity [NASA-CR-195516] p 131 N94-24810  
Bioregenerative system components for microgravity p 132 N94-25673
- HESSLINK, R.**  
Rewarming methodologies in the field [AD-A274744] p 136 N94-26173
- HEUS, R.**  
The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724
- HILTON, KEVIN**  
Dust control for Enabler p 153 N94-25680
- HINKLE, CATHY**  
Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786
- HIPWELL, DEAN P.**  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation [AD-A274077] p 139 N94-25774
- HUEBNER-MOTHS, JANIS**  
Pax: A permanent base for human habitation of Mars p 154 N94-25706
- HUFF, T. L.**  
Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2 [NASA-CR-193883] p 129 N94-24310
- HYSINGER, CHRISTOPHER L.**  
Conceptual design of a device to measure hand swelling in a micro-gravity environment [NASA-CR-195509] p 147 N94-24330

## J

- JACOBS, P. A.**  
An exploratory stochastic model for toxic effects on cells [AD-A273438] p 131 N94-25146
- JANOWITZ, J.**  
Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation [DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- JENKINS, JAMES P.**  
A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109682] p 138 N94-24855
- JENSEN, DEAN G.**  
Hand controller commonality evaluation process p 145 N94-24197
- JIANG, JIAN-PING**  
Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936
- JOHNSON, ADRIEL D.**  
Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426
- JOHNSON, CURTIS D.**  
Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363
- JOHNSON, WALTER W.**  
Optical information in landing scenes p 152 N94-25511

## K

- KAISER, MARY K.**  
Evaluation of visual acuity with Gen 3 night vision goggles [NASA-TM-108792] p 140 N94-23974

## PERSONAL AUTHOR INDEX

- Proceedings of the Workshop on Augmented Visual Display (AVID) Research [NASA-CP-10128] p 151 N94-25490  
Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510
- KARAS, STEPHEN**  
Design of a recumbent seating system [NASA-CR-195503] p 148 N94-24786
- KARL, CHAD**  
Dust control for Enabler p 153 N94-25680
- KASTURI, RANGACHAR**  
A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507
- KIETZMAN, JOHN**  
Enabler operator station p 153 N94-25679
- KINCAID, P.**  
Rewarming methodologies in the field [AD-A274744] p 136 N94-26173
- KING, SHIRLYN**  
Enabler operator station p 153 N94-25679
- KIRULUTA, ANDREW MUWANGA**  
Predictive head movement tracking using innovations generated by Kalman filters [ISBN-0-315-83371-8] p 137 N94-24467
- KLAUS, D. M.**  
Autonomous support for microorganism research in space p 132 N94-25672
- KLEESPIES, HANK**  
The 1991-1992 project summaries p 154 N94-25698
- KROM, KIMBERLY J.**  
Robotics in a controlled, ecological life support system p 150 N94-25371
- KRUTZ, ROBERT W., JR.**  
Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

## L

- LARSSON, TOR**  
Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292
- LASSITER, CARROLL B.**  
Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368
- LAU, WAI-MAN**  
Interaction of tacrine at M(1) and M(2) cholinergic receptors in guinea pig brain p 129 N94-24294
- LEIBOWITZ, HERSCHEL W.**  
Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction p 137 N94-23979
- LEMAY, CHRISTOPHER S.**  
Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375
- LEWIS, JAMES L., JR.**  
Using computer graphics to design Space Station Freedom viewing p 144 N94-24191
- LEWIS, ROBERT**  
Process and representation in graphical displays p 143 N94-24187
- LIAO, JIANQIAO**  
Investigation of time and intensity effects in operator workload and performance [CTN-94-60927] p 142 N94-24171
- LIPPETT, BUDDY O.**  
Using computer graphics to design Space Station Freedom viewing p 144 N94-24191
- LITHERLAND, MARK**  
Dust control for Enabler p 153 N94-25680
- LOOBY, BRENT**  
Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667
- LU, LI-DAI**  
NASA project 1: Full-body dynamometer [NASA-CR-195507] p 148 N94-24331
- LUDWIG, DAVID A.**  
Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098
- LUNDIN, ENRICO**  
Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292
- LUTTGES, M. W.**  
Autonomous support for microorganism research in space p 132 N94-25672

## M

- MAGEE, MICHAEL**  
An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever p 150 N94-25369
- MAIDA, JAMES**  
Development of biomechanical models for human factors evaluations p 146 N94-24205  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206
- MALOAN, J.**  
Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research [DCIEM-93-05] p 147 N94-24299
- MANAHAN, MEERA**  
Spacecraft crew procedures from paper to computers p 143 N94-24186
- MARCUS, J. T.**  
The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724
- MARMOLEJO, JOSE A.**  
A simulation system for Space Station extravehicular activity p 144 N94-24192
- MCCARDIE, A. H.**  
Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179
- MCCARTY, EDWARD A.**  
A test of the theory of reasoned action at the group level of analysis [AD-A273965] p 139 N94-25897
- MCKEE, SANDRA D.**  
Using computer graphics to design Space Station Freedom viewing p 144 N94-24191
- MCMAHAN, ROBERT**  
Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom [NASA-CR-195508] p 149 N94-24835  
Conceptual design of an astronaut hand anthropometry device [NASA-CR-195490] p 149 N94-24956
- MCILLAN, SCOTT**  
Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle [NASA-CR-195504] p 148 N94-24667
- MENU, JEAN-PIERRE**  
Physical aspects of the visual stimulus p 141 N94-23978
- MICOCCHI, ANGELO**  
Use of infrared telemetry as part of a noninvasive inflight data collection system to collect human factors data p 144 N94-24193
- MILES, GAINES E.**  
Robotics in a controlled, ecological life support system p 150 N94-25371
- MILGRAM, PAUL**  
Investigation of time and intensity effects in operator workload and performance [CTN-94-60927] p 142 N94-24171
- MILLER, M. S.**  
Autonomous support for microorganism research in space p 132 N94-25672
- MILLER, NEIL E.**  
Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785] p 133 N94-24102
- MITCHELL, CHRISTINE M.**  
Intelligent tutoring and aiding in satellite ground control p 140 N94-23929
- MITCHELL, R.**  
Microbial biofilm formation and its consequences for the CELSS program [NASA-CR-195146] p 148 N94-24706
- MOORE, ERVETTE P.**  
Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198
- MOORE, GARY T.**  
Pax: A permanent base for human habitation of Mars p 154 N94-25706
- MORGAN, STEVE**  
Bioregenerative life support systems for microgravity [NASA-CR-195516] p 131 N94-24810
- MORIARTY, DEBRA M.**  
Evaluation of ovostatin and ovostatin assay p 130 N94-24437
- MOUNT, FRANCIS E.**  
Using computer graphics to design Space Station Freedom viewing p 144 N94-24191

## MOYNIHAN, GARY P.

- Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438

## MULENBURG, JERRY

- An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086

## MURPHY, ELIZABETH D.

- Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936

## N

## NAIK, DIPAK

- Design and simulation of EVA tools for first servicing mission of HST [NASA-CR-194784] p 149 N94-24857

## NEKSAE, P.

- EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

## NERI, D. F.

- Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

## NEVILL, GAIL E., JR.

- Bioregenerative life support systems for microgravity [NASA-CR-195516] p 131 N94-24810

## NEVILL, GALE E., JR.

- Bioregenerative system components for microgravity p 132 N94-25673

## NICHOLS, STEVEN P.

- The 1991-1992 project summaries p 154 N94-25698

## NULL, CYNTHIA H.

- A white paper: NASA virtual environment research, applications, and technology [NASA-TM-109682] p 138 N94-24855

## O

## ONEAL, MICHAEL

- Spacecraft crew procedures from paper to computers p 143 N94-24186

## ORTIZ, NELSON

- First lunar outpost p 154 N94-25694

## P

## PANDYA, ABHILASH

- Development of biomechanical models for human factors evaluations p 146 N94-24205  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206

## PARULESKI, KERRY L.

- Pax: A permanent base for human habitation of Mars p 154 N94-25706

## PAVEL, M

- Engineering workstation: Sensor modeling p 151 N94-25500

## PAVEL, M.

- Image fusion p 151 N94-25501  
Evaluation of image quality p 153 N94-25514

## PECARIC, M.

- Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research [DCIEM-93-05] p 147 N94-24299

## PERRONE, JOHN A.

- Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510

## PERSSON, AAKE

- Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

## PERSSON, GUNNAR

- Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

## PICCUS, MARTIN E.

- Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

## PICKERING, THOMAS G.

- Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785] p 133 N94-24102

## POZOS, R.

- Rewarming methodologies in the field [AD-A274744] p 136 N94-26173

## PROBE, JOHN D.

- Quantitative assessment of human motion using video motion analysis p 146 N94-24203

## R

## RADKE, JEFFREY

- Synthetic vision system flight test results and lessons learned p 139 N94-25492

## RAY, WILLIAM J.

- EEG and chaos: Description of underlying dynamics and its relation to dissociative states [NASA-CR-195171] p 138 N94-24799

## READING, J.

- Rewarming methodologies in the field [AD-A274744] p 136 N94-26173

## REBHOLZ, PATRICK J.

- Pax: A permanent base for human habitation of Mars p 154 N94-25706

## REID, JAMES R., JR.

- The AFIT multielectrode array for neural recording and stimulation: Design, testing, and encapsulation [AD-A274086] p 136 N94-25943

## RITCHIE, DAVID

- Dust control for Enabler p 153 N94-25680

## ROBERTS, BARRY

- Image processing for flight crew enhanced situation awareness p 152 N94-25508

## ROBERTSON, BOBBY J.

- Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375

## RODRIGUEZ, JOSE

- Bioregenerative life support systems for microgravity [NASA-CR-195516] p 131 N94-24810

## ROSQVIST, ROLAND

- Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290

## ROZENFELD, PAWEŁ

- Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933

## RUBIN, MARILYN

- Development of a model to assess orthostatic responses p 135 N94-25376

## RUBY, EDWARD G.

- Symbiosis in marine luminous bacteria [AD-A273540] p 130 N94-24791

## RUDISILL, MARIANNE

- Process and representation in graphical displays p 143 N94-24187

## S

## SABOUNI, IKHLAS

- Design and development of the second generation Mars Habitat p 154 N94-25693

## SALEM, HARRY

- Proceedings of the symposium on current concepts and approaches on animal test alternatives [AD-A273926] p 132 N94-25593

## SAMPAIO, CARLOS E.

- Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199  
Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200

## SCHAFER, LAUREN E.

- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations p 146 N94-24204

## SCHOUTEN, GERARD

- Luminance-brightness mapping: The missing decades [ETN-94-95351] p 138 N94-25298

## SCOTT, CAROL J.

- Training: Plugging the information gaps p 136 N94-23934

## SHAPIRO, DAVID

- Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785] p 133 N94-24102

## SHEPHERD, CHIP

- A simulation system for Space Station extravehicular activity p 144 N94-24192

## SHIPLEY, D. E.

- Autonomous support for microorganism research in space p 132 N94-25672

## SHUB, Y.

- Pilot evaluation system p 137 N94-24266

## SILVA, DANIEL

- First lunar outpost p 154 N94-25694

## SKELLY, JUNE J.

- Pacing visual attention: Temporal structure effects [AD-A273859] p 140 N94-25965

**SMITH, GARY A.****SMITH, GARY A.**

Creation of prototype aircrew protection equipment based on face anthropometry  
[AD-A273865] p 153 N94-25611

**SMITH, J. D.**

Autonomous support for microorganism research in space p 132 N94-25672

**SMITH, PHILLIP N.**

Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

**SMITH, RANDY L.**

Illumination requirements for operating a space remote manipulator p 144 N94-24195  
Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198  
Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199  
The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201  
Simulation of the human-telerobot interface on the Space Station p 146 N94-24202

**SMITH, ROBERT S.**

A chemical sensor and biosensor based totally automated water quality monitor for extended space flight: Step 1 p 148 N94-24447

**SMITH, ROY**

Design and development of the second generation Mars Habitat p 154 N94-25693

**SPIGGLE, CHARLES**

Variable speed controller p 153 N94-25678

**SRIDHAR, BANAVAR**

Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

**STAN-LOTTER, HELGA**

The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium [NASA-CR-193803] p 131 N94-24807  
The evolution of energy-transducing systems. Studies with archaeobacteria [NASA-CR-195129] p 131 N94-24811

**STANDLEY, BRIAN K.**

Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

**STANNY, R. R.**

Effects of methamphetamine on vigilance and tracking during extended wakefulness [AD-A274896] p 136 N94-26179

**STEWART, ERIC C.**

A simulation study of control and display requirements for zero-experience general aviation pilots p 149 N94-25102

**STOEREN, S.**

EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

**STONE, LELAND**

Extracting heading and temporal range from optic flow: Human performance issues p 152 N94-25510

**STOVER, RAE**

Enabler operator station p 153 N94-25679

**STUART, MARK A.**

Hand controller commonality evaluation process p 145 N94-24197  
Programmable display pushbuttons on the Space Station's telerobot control panel p 145 N94-24198  
Speech versus manual control of camera functions during a telerobotic task p 145 N94-24199  
Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility p 145 N94-24200  
The effects of spatially displaced visual feedback on remote manipulator performance p 146 N94-24201  
Simulation of the human-telerobot interface on the Space Station p 146 N94-24202

**SUN, NANCY**

Dust control for Enabler p 153 N94-25680

**SUORSA, RAYMOND E.**

Multiple-camera/motion stereoscopy for range estimation in helicopter flight p 151 N94-25505

**SURVANSI, S. S.**

A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure [AD-A273488] p 134 N94-24950

**SWEET, B.**

Engineering workstation: Sensor modeling p 151 N94-25500

**SWEET, BARBARA T.**

Proceedings of the Workshop on Augmented Visual Display (AVID) Research [NASA-CP-10128] p 151 N94-25490

**SWIFT, SHANNON**

Variable speed controller p 153 N94-25678

**SZILAGYI, MARIA**

Interaction of tacrine at M(1) and M(2) cholinergic receptors in guinea pig brain p 129 N94-24294

**T****TANG, YUAN-LIANG**

A model-based approach for detection of objects in low resolution passive-millimeter wave images p 151 N94-25507

**TASK, H. LEE**

Night vision devices and characteristics p 141 N94-23982  
Cockpit/NVG visual integration issues p 142 N94-23983

**TAYLOR, BRUCE C.**

Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378

**TAYLOR, STEVEN**

Design and development of the second generation Mars Habitat p 154 N94-25693

**THEEUWES, J.**

Endogenous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

**TISCHLER, MARC E.**

Skeletal muscle metabolism in hypokinetic rats [NASA-CR-195082] p 129 N94-24124

**TISTAD, LENA**

Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

**TODD, BETH A.**

Loading, electromyograph, and motion during exercise p 135 N94-25380

**TOSCANO, WILLIAM B.**

Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews [NASA-TM-108785] p 133 N94-24102

**TRUSZKOWSKI, WALTER F.**

Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES p 140 N94-23936

**TUCKER, NATHAN P.**

Automation of closed environments in space for human comfort and safety p 154 N94-25684

**U****ULVSAND, THOMAS**

Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

**V****VANGEFFEN, STEPHEN**

Variable speed controller p 153 N94-25678

**VARDAMAN, JENNIFER J.**

Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory [DOT/FAA/AM-94/5] p 155 N94-26136

**VASQUES, MARILYN**

An automatic 14-day paste diet feeder for animals [NASA-TM-108804] p 133 N94-26086

**VERNIKOS, JOAN**

Intermittent gravity: How much, how often, how long? [NASA-TM-108800] p 155 N94-26098

**VOLK, TAMI L.**

Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

**VRIJKOTTE, T. G.**

The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724

**W****WAYDA, MICHAEL E.**

Index to FAA Office of Aviation Medicine Reports: 1961 through 1993 [DOT/FAA/AM-94/1] p 133 N94-24093

**WEGNER, TORSTEN**

Enabler operator station p 153 N94-25679

**WERTHEIM, A. H.**

The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724

**WHEELWRIGHT, CHARLES D.**

Illumination requirements for operating a space remote manipulator p 144 N94-24195

**WILDES, LINDA B.**

Creation of prototype aircrew protection equipment based on face anthropometry [AD-A273865] p 153 N94-25611

**PERSONAL AUTHOR INDEX****WILMINGTON, ROBERT P.**

Hand controller commonality evaluation process p 145 N94-24197

**WITT, L. ALAN**

Perceptions of organizational support and affectivity as predictors of job satisfaction [DOT/FAA/AM-94/2] p 139 N94-25442

**WOLF-WATZ, HANS**

Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290

**WOOLFORD, BARBARA**

Previous experience in manned space flight: A survey of human factors lessons learned p 144 N94-24196  
Development of biomechanical models for human factors evaluations p 146 N94-24205  
Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study p 147 N94-24206

**Y****YOUNGER, FRANK**

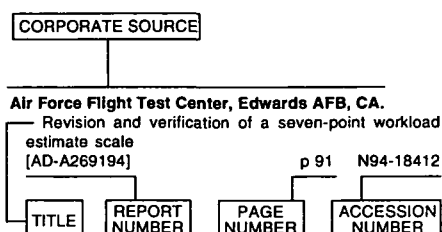
Variable speed controller p 153 N94-25678

# CORPORATE SOURCE INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 388)

May 1994

## Typical Corporate Source Index Listing



Listings in this index are arranged alphabetically by corporate source. The title of the document is used to provide a brief description of the subject matter. The page number and the accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

## A

- Advisory Group for Aerospace Research and Development, Neuilly-Sur-Seine (France).**  
Visual Problems in Night Operations  
[AGARD-LS-187] p 141 N94-23976
- Aerospace Medical Research Labs., Brooks AFB, TX.**  
Artificial gravity in space flight  
[AD-A273420] p 134 N94-24928
- Aerospace Medical Research Labs., Williams AFB, AZ.**  
Night operations p 141 N94-23977  
Night vision goggle illusions and visual training  
p 142 N94-23984
- Aerospace Medical Research Labs., Wright-Patterson AFB, OH.**  
Night vision devices and characteristics  
p 141 N94-23982  
Cockpit/NVG visual integration issues  
p 142 N94-23983
- Air Force Inst. of Tech., Wright-Patterson AFB, OH.**  
Creation of prototype aircrew protection equipment based on face anthropometry  
[AD-A273865] p 153 N94-25611  
Developing realistic cooperative behaviors for autonomous agents in air combat simulation  
[AD-A274077] p 139 N94-25774  
A test of the theory of reasoned action at the group level of analysis  
[AD-A273965] p 139 N94-25897  
The AFIT multielectrode array for neural recording and simulation: Design, testing, and encapsulation  
[AD-A274086] p 136 N94-25943
- Akron Univ., OH.**  
Evaluation of bioimpedance for the measurement of physiologic variables as related to hemodynamic studies in space flight p 135 N94-25378
- Alabama Univ., Huntsville.**  
Measuring the dynamics of structural changes in biological macromolecules from light scattering data p 130 N94-24426

- Evaluation of ovostatin and ovostatin assay p 130 N94-24437  
Evaluation of computer-aided instruction techniques for the crew interface coordination position p 137 N94-24438  
Loading, electromyograph, and motion during exercise p 135 N94-25380
- Arizona Univ., Tucson.**  
Skeletal muscle metabolism in hypokinetic rats  
[NASA-CR-195082] p 129 N94-24124

## B

- Bevill State Community Coll., Fayette, AL.**  
Investigating pyrolysis/incineration as a method of resource recovery from solid waste p 151 N94-25375
- Brooke Army Medical Center, Fort Sam Houston, TX.**  
Annual research progress report, fiscal year 1992. Volume 2: Department of Clinical Investigation  
[AD-A273584] p 134 N94-24945

## C

- Centre d'Enseignement et de Recherches de Medecine Aeronautique, Paris (France).**  
Physical aspects of the visual stimulus  
Mental images p 141 N94-23978  
Multi-sensoral approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981
- Civil Aeromedical Inst., Oklahoma City, OK.**  
Index to FAA Office of Aviation Medicine Reports: 1961 through 1993  
[DOT/FAA/AM-94/1] p 133 N94-24093
- Colorado Univ., Boulder.**  
Autonomous support for microorganism research in space p 132 N94-25672

## D

- Defence and Civil Inst. of Environmental Medicine, Downsview (Ontario).**  
Physiological protection for aircrew at high altitudes: A review of the literature  
[DCIEM-93-13] p 142 N94-24114  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew  
[DCIEM-93-06] p 142 N94-24119  
Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human + Gz research  
[DCIEM-93-05] p 147 N94-24299

## E

- Edgewood Arsenal, Aberdeen Proving Ground, MD.**  
Proceedings of the symposium on current concepts and approaches on animal test alternatives  
[AD-A273926] p 132 N94-25593
- Essex Corp., Orlando, FL.**  
Transfer of perceptual adaptation to space sickness: What enhances an individual's ability to adapt?  
[NASA-CR-188256] p 134 N94-24227
- EXOS, Inc., Woburn, MA.**  
Development of a force feedback anthropomorphic teleoperation input device for control of robot hands  
[NASA-CR-195109] p 147 N94-24329

## F

- Federal Aviation Administration, Atlantic City, NJ.**  
Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory  
[DOT/FAA/AM-94/5] p 155 N94-26136
- Federal Aviation Administration, Oklahoma City, OK.**  
Perceptions of organizational support and affectivity as predictors of job satisfaction  
[DOT/FAA/AM-94/2] p 139 N94-25442

- Human factors in airway facilities maintenance: Development of a prototype outage assessment inventory  
[DOT/FAA/AM-94/5] p 155 N94-26136
- Florida Univ., Gainesville.**  
Bioregenerative life support systems for microgravity  
[NASA-CR-195516] p 131 N94-24810  
Bioregenerative system components for microgravity p 132 N94-25673

## G

- Galaxy Scientific Corp., Pleasantville, NJ.**  
Pilot-vehicle interface handbook, chapter 19. Volume 2: Digital systems validation  
[DOT/FAA/CT-88/10-VOL-2] p 149 N94-24830
- Georgia Inst. of Tech., Atlanta.**  
Variable speed controller p 153 N94-25678  
Enabler operator station p 153 N94-25679  
Dust control for Enabler p 153 N94-25680

## H

- Harvard Univ., Cambridge, MA.**  
Microbial biofilm formation and its consequences for the CELSS program  
[NASA-CR-195146] p 148 N94-24706
- Honeywell, Inc., Minneapolis, MN.**  
Intelligent tutoring and aiding in satellite ground control p 140 N94-23929  
Synthetic vision system flight test results and lessons learned p 139 N94-25492  
Image processing for flight crew enhanced situation awareness p 152 N94-25508
- Houston Univ., Clear Lake, TX.**  
Design and testing of a unique randomized gravity, continuous flow bioreactor p 132 N94-25368
- Houston Univ., TX.**  
Image remapping strategies applied as prostheses for the visually impaired p 150 N94-25363  
Portable Habitat for Antarctic Scientific Research (PHASR) p 153 N94-25681

## I

- Institute for Perception RVO-TNO, Soesterberg (Netherlands).**  
The effect of platform motion on human energy expenditure during walking. An exploratory experiment  
[AD-A273760] p 155 N94-25724  
Endogeneous and exogenous control of visual selection: A review of the literature  
[AD-A273761] p 135 N94-25871
- Instituto de Pesquisas Espaciais, Sao Jose dos Campos (Brazil).**  
Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933
- Israel Aircraft Industries Ltd., Tashan.**  
Pilot evaluation system p 137 N94-24266

## J

- Jet Propulsion Lab., California Inst. of Tech., Pasadena.**  
Training: Plugging the information gaps p 136 N94-23934

## K

- Kansas State Univ., Manhattan.**  
Automation of closed environments in space for human comfort and safety p 154 N94-25684

L

- Lockheed Engineering and Sciences Co., Houston, TX.**  
Spacecraft crew procedures from paper to computers  
p 143 N94-24186
- Automated system function allocation and display format: Task information processing requirements  
p 143 N94-24189
- The use of analytical models in human-computer interface design  
p 143 N94-24190
- Use of infrared telemetry as part of a nonintrusive inflight data collection system to collect human factors data  
p 144 N94-24193
- Programmable display pushbuttons on the Space Station's telerobot control panel  
p 145 N94-24198
- Speech versus manual control of camera functions during a telerobotic task  
p 145 N94-24199
- Space Station Freedom coupling tasks: An evaluation of their telerobotic and EVA compatibility  
p 145 N94-24200
- The effects of spatially displaced visual feedback on remote manipulator performance  
p 146 N94-24201
- Simulation of the human-telerobot interface on the Space Station  
p 146 N94-24202
- Quantitative assessment of human motion using video motion analysis  
p 146 N94-24203

M

- Materials Research Labs., Ascot Vale (Australia).**  
Interaction of tacrine at M(1) and M(2) cholinergic receptors in guinea pig brain  
p 129 N94-24294
- Minnesota Univ., Minneapolis.**  
Mechanisms of eye-hand coordination  
[AD-A273687] p 139 N94-25437
- Mount Holyoke Coll., South Hadley, MA.**  
The role of visual context in manual target localization  
p 138 N94-25351

N

- National Academy of Sciences - National Research Council, Washington, DC.**  
A biological survey for the nation  
[LC-93-85920] p 130 N94-24704
- National Aeronautics and Space Administration, Washington, DC.**  
A white paper: NASA virtual environment research, applications, and technology  
[NASA-TM-109682] p 138 N94-24855
- National Aeronautics and Space Administration, Ames Research Center, Moffett Field, CA.**  
Reducing video frame rate increases remote optimal focus time  
[NASA-TM-104018] p 140 N94-23970
- Evaluation of visual acuity with Gen 3 night vision goggles  
[NASA-TM-108792] p 140 N94-23974
- Autogenic-feedback training: A potential treatment for post-flight orthostatic intolerance in aerospace crews  
[NASA-TM-108785] p 133 N94-24102
- The evolution of energy-transducing systems. Studies with an extremely halophilic archaeobacterium  
[NASA-CR-193803] p 131 N94-24807
- The evolution of energy-transducing systems. Studies with archaeobacteria  
[NASA-CR-195129] p 131 N94-24811
- Proceedings of the Workshop on Augmented Visual Display (AVID) Research  
[NASA-CP-10128] p 151 N94-25490
- Engineering workstation: Sensor modeling  
p 151 N94-25500
- Image fusion  
p 151 N94-25501
- Multiple-camera/motion stereoscopy for range estimation in helicopter flight  
p 151 N94-25505
- Extracting heading and temporal range from optic flow: Human performance issues  
p 152 N94-25510
- Optical information in landing scenes  
p 152 N94-25511
- Sensor fusion display evaluation using information integration models in enhanced/synthetic vision applications  
p 152 N94-25512
- Quality metrics for sensor images  
p 152 N94-25513
- Evaluation of image quality  
p 153 N94-25514
- An automatic 14-day paste diet feeder for animals  
[NASA-TM-108804] p 133 N94-26086
- Plasma volume shifts and exercise thermoregulation with water immersion and six-degree head-down tilt  
[NASA-TM-108781] p 133 N94-26093
- Intermittent gravity: How much, how often, how long?  
[NASA-TM-108800] p 155 N94-26098
- Thermoregulatory effects of caffeine ingestion during rest and exercise in men  
[NASA-TM-108783] p 133 N94-26210

- National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, MD.**  
Automating a human factors evaluation of graphical user interfaces for NASA applications: An update on CHIMES  
p 140 N94-23936
- National Aeronautics and Space Administration, Lyndon B. Johnson Space Center, Houston, TX.**  
Crew interface analysis: Selected articles on space human factors research, 1987 - 1991  
[NASA-TM-104756] p 142 N94-24185
- Process and representation in graphical displays  
p 143 N94-24187
- Using computer graphics to design Space Station Freedom viewing  
p 144 N94-24191
- A simulation system for Space Station extravehicular activity  
p 144 N94-24192
- Illumination requirements for operating a space remote manipulator  
p 144 N94-24195
- Previous experience in manned space flight: A survey of human factors lessons learned  
p 144 N94-24196
- Hand controller commonality evaluation process  
p 145 N94-24197
- Reach performance while wearing the Space Shuttle launch and entry suit during exposure to launch accelerations  
p 146 N94-24204
- Development of biomechanical models for human factors evaluations  
p 146 N94-24205
- Establishing a relationship between maximum torque production of isolated joints to simulate EVA ratchet push-pull maneuver: A case study  
p 147 N94-24206
- National Aeronautics and Space Administration, Langley Research Center, Hampton, VA.**  
A simulation study of control and display requirements for zero-experience general aviation pilots  
p 149 N94-25102
- A model-based approach for detection of objects in low resolution passive-millimeter wave images  
p 151 N94-25507
- National Defence Research Establishment, Umea (Sweden).**  
Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption  
[FOA-B-40418-4.4] p 129 N94-24290
- Towards a new radiation protection organization  
[FOA-C-40304-4.3] p 147 N94-24292
- Naval Aerospace Medical Research Lab., Pensacola, FL.**  
Effects of methamphetamine on vigilance and tracking during extended wakefulness  
[AD-A274896] p 136 N94-26179
- Naval Health Research Center, San Diego, CA.**  
Rewarming methodologies in the field  
[AD-A274744] p 136 N94-26173
- Naval Medical Research Inst., Bethesda, MD.**  
A statistical analysis of recent Naval Experimental Diving Unit (NEDU) single-depth human exposures to 100 percent oxygen at pressure  
p 134 N94-24950
- Naval Postgraduate School, Monterey, CA.**  
An exploratory stochastic model for toxic effects on cells  
[AD-A273438] p 131 N94-25146
- Nebraska Univ., Omaha.**  
Investigation of hand capabilities under a variety of performance conditions and an attempt to explain performance differences  
p 150 N94-25354
- North Carolina Univ., Chapel Hill.**  
Auditory spectro-temporal pattern analysis  
[AD-A273554] p 134 N94-24865
- North Carolina Univ., Charlotte.**  
Design and simulation of EVA tools for first servicing mission of HST  
[NASA-CR-194784] p 149 N94-24857
- Ohio State Univ., Columbus.**  
Pacing visual attention: Temporal structure effects  
[AD-A273859] p 140 N94-25965
- Pennsylvania State Univ., University Park.**  
Perception in flight: Shape and motion perception, space perception, spatial orientation, and visual vestibular interaction  
p 137 N94-23979
- EEG and chaos: Description of underlying dynamics and its relation to dissociative states  
[NASA-CR-195171] p 138 N94-24799
- Prairie View Agricultural and Mechanical Coll., TX.**  
Design and development of the second generation Mars Habitat  
p 154 N94-25693
- Puerto Rico Univ., Rio Piedras.**  
First lunar outpost  
p 154 N94-25694

O

P

- Purdue Univ., West Lafayette, IN.**  
Robotics in a controlled, ecological life support system  
p 150 N94-25371
- Rice Univ., Houston, TX.**  
Designers' models of the human-computer interface  
p 143 N94-24188
- Saint John Fisher Coll., Rochester, NY.**  
A chemical sensor and biosensor based totally automated water quality monitor for extended space flight: Step 1  
p 148 N94-24447
- Saint Louis Univ., MO.**  
Development of a model to assess orthostatic responses  
p 135 N94-25376
- Seiskapet for Industriell og Teknisk Forskning, Trondheim (Norway).**  
EcarHeart2 version 1.0: Programmers documentation  
[PB94-124633] p 136 N94-25909
- SRI International Corp., Menlo Park, CA.**  
In vitro system for studying metabolism of environmental chemicals in human cells  
[AD-A273427] p 130 N94-24688
- Sverdrup Technology, Inc., Huntsville, AL.**  
Microbiological analysis of debris from Space Transportation System (STS)-55 Spacelab D-2  
[NASA-CR-193883] p 129 N94-24310
- Technische Univ., Eindhoven (Netherlands).**  
Luminance-brightness mapping: The missing decades  
[ETN-94-95351] p 138 N94-25298
- Texas A&M Univ., College Station.**  
Non-invasive optical detection of glucose in cell culture nutrient medium  
p 131 N94-25357
- Texas Univ., Austin.**  
Conceptual design of a device to measure hand swelling in a micro-gravity environment  
[NASA-CR-195509] p 147 N94-24330
- NASA project 1: Full-body dynamometer  
[NASA-CR-195507] p 148 N94-24331
- Concepts and embodiment design of a reentry recumbent seating system for the NASA Space Shuttle  
[NASA-CR-195504] p 148 N94-24667
- Design of a recumbent seating system  
[NASA-CR-195503] p 148 N94-24786
- Specification list and function structure for a full-body dynamometer to be used aboard Space Station Freedom  
[NASA-CR-195508] p 149 N94-24835
- Conceptual design of an astronaut hand anthropometry device  
[NASA-CR-195490] p 149 N94-24956
- The 1991-1992 project summaries  
p 154 N94-25698
- Toronto Univ. (Ontario).**  
Investigation of time and intensity effects in operator workload and performance  
[CTN-94-60927] p 142 N94-24171
- Predictive head movement tracking using innovations generated by Kalman filters  
[ISBN-0-315-83371-8] p 137 N94-24467
- Tulane Univ., New Orleans, LA.**  
Loading, electromyograph, and motion during exercise  
p 134 N94-25359
- University of Southern California, Los Angeles.**  
Symbiosis in marine luminous bacteria  
[AD-A273540] p 130 N94-24791
- Wisconsin Univ., Milwaukee.**  
Pax: A permanent base for human habitation of Mars  
p 154 N94-25706
- Wyoming Univ., Laramie.**  
An evaluation of three-dimensional sensors for the extravehicular activity helper/retriever  
p 150 N94-25369

R

S

T

U

W

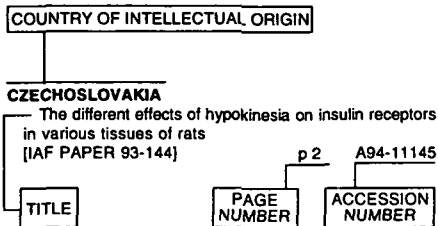


# FOREIGN TECHNOLOGY INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 388)

May 1994

## Typical Foreign Technology Index Listing



Listings in this index are arranged alphabetically by country of intellectual origin. The title of the document is used to provide a brief description of the subject matter. The page number and accession number are included in each entry to assist the user in locating the abstract in the abstract section. If applicable, a report number is also included as an aid in identifying the document.

## A

**AUSTRALIA**  
Interaction of tacrine at M(1) and M(2) cholinergic receptors in guinea pig brain p 129 N94-24294

## B

**BRAZIL**  
Operational training for the mission operations at the Brazilian National Institute for Space Research (INPE) p 136 N94-23933

## C

**CANADA**  
Physiological protection for aircrew at high altitudes: A review of the literature [DCIEM-93-13] p 142 N94-24114  
Operation Friction: Development and introduction of personal cooling for CH124 Sea King aircrew [DCIEM-93-06] p 142 N94-24119  
Investigation of time and intensity effects in operator workload and performance [CTN-94-60927] p 142 N94-24171  
Computer control of an electro-mechanical regulator for providing positive pressure breathing and an electronic G-valve for human +Gz research [DCIEM-93-05] p 147 N94-24299  
Predictive head movement tracking using innovations generated by Kalman filters [ISBN-0-315-83371-8] p 137 N94-24467

## F

**FRANCE**  
Visual Problems in Night Operations [AGARD-LS-187] p 141 N94-23976

Physical aspects of the visual stimulus p 141 N94-23978  
Mental images p 137 N94-23980  
Multi-sensoral approach to night flight: Perceptive and Cognitive limitations p 141 N94-23981

## I

**ISRAEL**  
Pilot evaluation system p 137 N94-24266

## N

**NETHERLANDS**  
Luminance-brightness mapping: The missing decades [ETN-94-95351] p 138 N94-25298  
The effect of platform motion on human energy expenditure during walking. An exploratory experiment [AD-A273760] p 155 N94-25724  
Endogeneous and exogenous control of visual selection: A review of the literature [AD-A273761] p 135 N94-25871

**NORWAY**  
EcarHeart2 version 1.0: Programmers documentation [PB94-124633] p 136 N94-25909

## P

**PUERTO RICO**  
First lunar outpost p 154 N94-25694

## S

**SWEDEN**  
Microinjection of the Yersinia YopE cytotoxin in mammalian cells induces actin microfilament disruption [FOA-B-40418-4.4] p 129 N94-24290  
Towards a new radiation protection organization [FOA-C-40304-4.3] p 147 N94-24292

FOREIGN

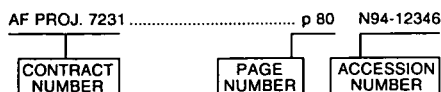
# CONTRACT NUMBER INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 388)

May 1994

## Typical Contract Number Index Listing

STUF-90-005-770 ..... p 129 N94-24290



Listings in this index are arranged alphanumerically by contract number. Under each contract number the accession numbers denoting documents that have been produced as a result of research done under the contract are shown. The accession number denotes the number by which the citation is identified in the abstract section. Preceding the accession number is the page number on which the citation may be found.

|                                |       |           |
|--------------------------------|-------|-----------|
| AF PROJ. 7184 .....            | p 140 | N94-25965 |
| AF PROJ. 7930 .....            | p 134 | N94-24928 |
| BU-4426-301 .....              | p 129 | N94-24290 |
| DA PROJ. 101-62622-A-553 ..... | p 132 | N94-25593 |
| DTFA03-89-C-0043 .....         | p 149 | N94-24830 |
| F40620-93-1-0045 .....         | p 134 | N94-24865 |
| F49620-91-C-0050 .....         | p 130 | N94-24688 |
| NAGW-227 .....                 | p 129 | N94-24124 |
| NAG1-1371 .....                | p 151 | N94-25507 |
| NAG1-1441 .....                | p 138 | N94-24799 |
| NAG2-384 .....                 | p 129 | N94-24124 |
| NAG5-2038 .....                | p 149 | N94-24857 |
| NASW-4435 .....                | p 147 | N94-24330 |
|                                | p 148 | N94-24331 |
|                                | p 148 | N94-24667 |
|                                | p 148 | N94-24786 |
|                                | p 131 | N94-24810 |
|                                | p 149 | N94-24835 |
|                                | p 149 | N94-24956 |
| NAS5-28575 .....               | p 140 | N94-23929 |
| NAS5-30680 .....               | p 140 | N94-23936 |
| NAS8-37814 .....               | p 129 | N94-24310 |
| NAS8-39364 .....               | p 147 | N94-24329 |
| NAS9-17900 .....               | p 143 | N94-24186 |
|                                | p 143 | N94-24188 |
|                                | p 144 | N94-24195 |
|                                | p 144 | N94-24196 |
|                                | p 145 | N94-24198 |
|                                | p 145 | N94-24199 |
|                                | p 145 | N94-24200 |
|                                | p 146 | N94-24201 |
|                                | p 146 | N94-24202 |
| NAS9-18035 .....               | p 134 | N94-24227 |
| NCC2-486 .....                 | p 151 | N94-25501 |
| NCC2-578 .....                 | p 131 | N94-24807 |
|                                | p 131 | N94-24811 |
| NCC2-628 .....                 | p 148 | N94-24706 |
| NGT-50686 .....                | p 133 | N94-26093 |
| NMRI PROJ. M00-99 .....        | p 134 | N94-24950 |
| NR PROJ. M00-96 .....          | p 136 | N94-26173 |
|                                | p 136 | N94-26179 |
| N00014-92-J-1716 .....         | p 130 | N94-24791 |
| N00014-92-J-1905 .....         | p 139 | N94-25437 |
| RTOP 199-08-12-06 .....        | p 133 | N94-26086 |
| RTOP 199-14-12-06 .....        | p 133 | N94-24102 |
| RTOP 199-14-12-11 .....        | p 155 | N94-26098 |
| RTOP 199-18-12-07 .....        | p 133 | N94-26093 |
|                                | p 133 | N94-26210 |
| RTOP 476-14-03 .....           | p 140 | N94-23970 |
| RTOP 505-64-36 .....           | p 151 | N94-25490 |
| SMRC-07-490-5A .....           | p 129 | N94-24290 |

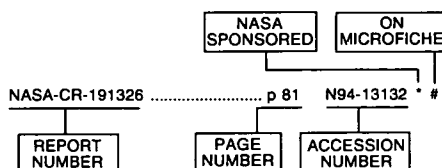
CONTRACT

# REPORT NUMBER INDEX

AEROSPACE MEDICINE AND BIOLOGY / A Continuing Bibliography (Supplement 388)

May 1994

## Typical Report Number Index Listing



Listings in this index are arranged alphanumerically by report number. The page number indicates the page on which the citation is located. The accession number denotes the number by which the citation is identified. An asterisk (\*) indicates that the item is a NASA report. A pound sign (#) indicates that the item is available on microfiche.

A-93075 ..... p 140 N94-23970 \* #  
 A-93097 ..... p 133 N94-26093 \* #  
 A-93099 ..... p 133 N94-26210 \* #  
 A-93109 ..... p 133 N94-24102 \* #  
 A-93123 ..... p 151 N94-25490 \* #  
 A-93134 ..... p 140 N94-23974 \* #  
 A-94027 ..... p 155 N94-26098 \* #  
 A-94037 ..... p 133 N94-26086 \* #  
  
 AD-A273420 ..... p 134 N94-24928  
 AD-A273427 ..... p 130 N94-24688  
 AD-A273438 ..... p 131 N94-25146 #  
 AD-A273488 ..... p 134 N94-24950 #  
 AD-A273540 ..... p 130 N94-24791 #  
 AD-A273554 ..... p 134 N94-24865  
 AD-A273584 ..... p 134 N94-24945 #  
 AD-A273687 ..... p 139 N94-25437 #  
 AD-A273760 ..... p 155 N94-25724 #  
 AD-A273761 ..... p 135 N94-25871 #  
 AD-A273859 ..... p 140 N94-25965  
 AD-A273865 ..... p 153 N94-25611 #  
 AD-A273926 ..... p 132 N94-25593 #  
 AD-A273965 ..... p 139 N94-25897 #  
 AD-A274077 ..... p 139 N94-25774 #  
 AD-A274086 ..... p 136 N94-25943 #  
 AD-A274744 ..... p 136 N94-26173 #  
 AD-A274896 ..... p 136 N94-26179 #  
  
 AFIT/GCE/ENG/93D-05 ..... p 139 N94-25774 #  
 AFIT/GE/ENG/93D-33 ..... p 136 N94-25943 #  
 AFIT/GLM/LAR/93S-16 ..... p 139 N94-25897 #  
 AFIT/GSE/ENY/93D-2 ..... p 153 N94-25611 #  
  
 AFOSR-93-0854TR ..... p 130 N94-24688  
 AFOSR-93-0856TR ..... p 134 N94-24865  
  
 AGARD-LS-187 ..... p 141 N94-23976 #  
  
 AL-TR-1993-0024 ..... p 140 N94-25965  
  
 AL/CF-PC-1993-0040 ..... p 134 N94-24928  
  
 CTN-94-60895 ..... p 142 N94-24114  
 CTN-94-60912 ..... p 147 N94-24299  
 CTN-94-60915 ..... p 142 N94-24119  
 CTN-94-60927 ..... p 142 N94-24171  
 CTN-94-60957 ..... p 137 N94-24467  
  
 DCIEM-93-05 ..... p 147 N94-24299  
 DCIEM-93-06 ..... p 142 N94-24119  
 DCIEM-93-13 ..... p 142 N94-24114

DOT/FAA/AM-94/1 ..... p 133 N94-24093 #  
 DOT/FAA/AM-94/2 ..... p 139 N94-25442 #  
 DOT/FAA/AM-94/5 ..... p 155 N94-26136 #  
  
 DOT/FAA/CT-88/10-VOL-2 ..... p 149 N94-24830 #  
  
 ERDEC-SP-012 ..... p 132 N94-25593 #  
  
 ETN-93-93763 ..... p 129 N94-24290 #  
 ETN-93-94490 ..... p 147 N94-24292 #  
 ETN-94-95351 ..... p 138 N94-25298  
  
 FOA-B-40418-4.4 ..... p 129 N94-24290 #  
 FOA-C-40304-4.3 ..... p 147 N94-24292 #  
  
 ISBN-0-309-04984-0 ..... p 130 N94-24704  
 ISBN-0-315-83371-8 ..... p 137 N94-24467  
 ISBN-92-835-0676-6 ..... p 141 N94-23976 #  
  
 IZF-1993-B-10 ..... p 155 N94-25724 #  
 IZF-1993-B-9 ..... p 135 N94-25871 #  
  
 LC-93-85920 ..... p 130 N94-24704  
  
 NAMRL-1386 ..... p 136 N94-26179 #  
  
 NAS 1.15:104018 ..... p 140 N94-23970 \* #  
 NAS 1.15:104756 ..... p 142 N94-24185 \* #  
 NAS 1.15:108781 ..... p 133 N94-26093 \* #  
 NAS 1.15:108783 ..... p 133 N94-26210 \* #  
 NAS 1.15:108785 ..... p 133 N94-24102 \* #  
 NAS 1.15:108792 ..... p 140 N94-23974 \* #  
 NAS 1.15:108800 ..... p 155 N94-26098 \* #  
 NAS 1.15:108804 ..... p 133 N94-26086 \* #  
 NAS 1.15:109682 ..... p 138 N94-24855 \* #  
 NAS 1.26:188256 ..... p 134 N94-24227 \* #  
 NAS 1.26:193803 ..... p 131 N94-24807 \* #  
 NAS 1.26:193883 ..... p 129 N94-24310 \* #  
 NAS 1.26:194784 ..... p 149 N94-24857 \* #  
 NAS 1.26:195082 ..... p 129 N94-24124 \* #  
 NAS 1.26:195109 ..... p 147 N94-24329 \* #  
 NAS 1.26:195129 ..... p 131 N94-24811 \* #  
 NAS 1.26:195146 ..... p 148 N94-24706 \* #  
 NAS 1.26:195171 ..... p 138 N94-24799 \* #  
 NAS 1.26:195490 ..... p 149 N94-24956 \* #  
 NAS 1.26:195503 ..... p 148 N94-24786 \* #  
 NAS 1.26:195504 ..... p 148 N94-24667 \* #  
 NAS 1.26:195507 ..... p 148 N94-24331 \* #  
 NAS 1.26:195508 ..... p 149 N94-24835 \* #  
 NAS 1.26:195509 ..... p 147 N94-24330 \* #  
 NAS 1.26:195516 ..... p 131 N94-24810 \* #  
 NAS 1.55:10128 ..... p 151 N94-25490 \* #  
  
 NASA-CP-10128 ..... p 151 N94-25490 \* #  
  
 NASA-CR-188256 ..... p 134 N94-24227 \* #  
 NASA-CR-193803 ..... p 131 N94-24807 \* #  
 NASA-CR-193883 ..... p 129 N94-24310 \* #  
 NASA-CR-194784 ..... p 149 N94-24857 \* #  
 NASA-CR-195082 ..... p 129 N94-24124 \* #  
 NASA-CR-195109 ..... p 147 N94-24329 \* #  
 NASA-CR-195129 ..... p 131 N94-24811 \* #  
 NASA-CR-195146 ..... p 148 N94-24706 \* #  
 NASA-CR-195171 ..... p 138 N94-24799 \* #  
 NASA-CR-195490 ..... p 149 N94-24956 \* #  
 NASA-CR-195503 ..... p 148 N94-24786 \* #  
 NASA-CR-195504 ..... p 148 N94-24667 \* #  
 NASA-CR-195507 ..... p 148 N94-24331 \* #  
 NASA-CR-195508 ..... p 149 N94-24835 \* #  
 NASA-CR-195509 ..... p 147 N94-24330 \* #  
 NASA-CR-195516 ..... p 131 N94-24810 \* #  
  
 NASA-TM-104018 ..... p 140 N94-23970 \* #  
 NASA-TM-104756 ..... p 142 N94-24185 \* #  
 NASA-TM-108781 ..... p 133 N94-26093 \* #  
 NASA-TM-108783 ..... p 133 N94-26210 \* #  
 NASA-TM-108785 ..... p 133 N94-24102 \* #  
 NASA-TM-108792 ..... p 140 N94-23974 \* #  
 NASA-TM-108800 ..... p 155 N94-26098 \* #  
 NASA-TM-108804 ..... p 133 N94-26086 \* #  
 NASA-TM-109682 ..... p 138 N94-24855 \* #  
  
 NHRC-93-4 ..... p 136 N94-26173 #  
  
 NMRI-93-59 ..... p 134 N94-24950 #  
  
 NPS-OR-93-104 ..... p 131 N94-25146 #  
  
 PB94-124633 ..... p 136 N94-25909  
  
 S-697 ..... p 142 N94-24185 \* #  
  
 STF23-A93028 ..... p 136 N94-25909  
  
 TDCK-TD-93-1361 ..... p 135 N94-25871 #  
 TDCK-TD-93-1366 ..... p 155 N94-25724 #  
  
 TR-ME/ES-93-2 ..... p 149 N94-24857 \* #

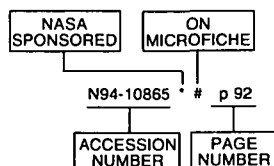
REPORT

# ACCESSION NUMBER INDEX

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May 1994

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N94-25679 \* # p 153  
 N94-25680 \* # p 153  
 N94-25681 \* # p 153  
 N94-25684 \* # p 154  
 N94-25693 \* # p 154  
 N94-25694 \* # p 154  
 N94-25698 \* # p 154  
 N94-25706 \* # p 154  
 N94-25724 # p 155  
 N94-25774 # p 139  
 N94-25871 # p 135  
 N94-25897 # p 139  
 N94-25909 # p 136  
 N94-25943 # p 136  
 N94-25965 # p 140  
 N94-26086 \* # p 133  
 N94-26093 \* # p 133  
 N94-26098 \* # p 155  
 N94-26136 # p 155  
 N94-26173 # p 136  
 N94-26179 # p 136  
 N94-26210 \* # p 133

N94-23929 \* # p 140  
 N94-23933 \* # p 136  
 N94-23934 \* # p 136  
 N94-23936 \* # p 140  
 N94-23970 \* # p 140  
 N94-23974 \* # p 140  
 N94-23976 # p 141  
 N94-23977 # p 141  
 N94-23978 # p 141  
 N94-23979 # p 137  
 N94-23980 # p 137  
 N94-23981 # p 141  
 N94-23982 # p 141  
 N94-23983 # p 142  
 N94-23984 # p 142  
 N94-24093 # p 133  
 N94-24102 \* # p 133  
 N94-24114 # p 142  
 N94-24119 # p 142  
 N94-24124 \* # p 129  
 N94-24171 # p 142  
 N94-24185 \* # p 142  
 N94-24186 \* # p 143  
 N94-24187 \* # p 143  
 N94-24188 \* # p 143  
 N94-24189 \* # p 143  
 N94-24190 \* # p 143  
 N94-24191 \* # p 144  
 N94-24192 \* # p 144  
 N94-24193 \* # p 144  
 N94-24195 \* # p 144  
 N94-24196 \* # p 144  
 N94-24197 \* # p 145  
 N94-24198 \* # p 145  
 N94-24199 \* # p 145  
 N94-24200 \* # p 145  
 N94-24201 \* # p 146  
 N94-24202 \* # p 146  
 N94-24203 \* # p 146  
 N94-24204 \* # p 146  
 N94-24205 \* # p 146  
 N94-24206 \* # p 147  
 N94-24227 \* # p 134  
 N94-24266 # p 137  
 N94-24290 # p 129  
 N94-24292 # p 147  
 N94-24294 # p 129  
 N94-24299 # p 147  
 N94-24310 \* # p 129  
 N94-24329 \* # p 147  
 N94-24330 \* # p 147  
 N94-24331 \* # p 148  
 N94-24426 \* # p 130  
 N94-24437 \* # p 130  
 N94-24438 \* # p 137  
 N94-24447 \* # p 148  
 N94-24467 # p 137  
 N94-24667 \* # p 148  
 N94-24688 # p 130  
 N94-24704 # p 130  
 N94-24706 \* # p 148  
 N94-24786 \* # p 148  
 N94-24791 # p 130  
 N94-24799 \* # p 138  
 N94-24807 \* # p 131  
 N94-24810 \* # p 131  
 N94-24811 \* # p 131  
 N94-24830 # p 149  
 N94-24835 \* # p 149  
 N94-24855 \* # p 138  
 N94-24857 \* # p 149  
 N94-24865 # p 134  
 N94-24928 # p 134  
 N94-24945 # p 134  
 N94-24950 # p 134  
 N94-24956 \* # p 149  
 N94-25102 \* # p 149  
 N94-25146 # p 131  
 N94-25298 # p 138  
 N94-25351 \* # p 138  
 N94-25354 \* # p 150  
 N94-25357 \* # p 131  
 N94-25359 \* # p 134  
 N94-25363 \* # p 150  
 N94-25368 \* # p 132  
 N94-25369 \* # p 150  
 N94-25371 \* # p 150  
 N94-25375 \* # p 151  
 N94-25376 \* # p 135  
 N94-25378 \* # p 135  
 N94-25380 \* # p 135  
 N94-25437 # p 139  
 N94-25442 \* # p 139  
 N94-25490 \* # p 151  
 N94-25492 \* # p 139  
 N94-25500 \* # p 151  
 N94-25501 \* # p 151  
 N94-25505 \* # p 151  
 N94-25507 \* # p 151  
 N94-25508 \* # p 152  
 N94-25510 \* # p 152  
 N94-25511 \* # p 152  
 N94-25512 \* # p 152  
 N94-25513 \* # p 152  
 N94-25514 \* # p 153  
 N94-25593 # p 132  
 N94-25611 # p 153  
 N94-25672 \* # p 132  
 N94-25673 \* # p 132  
 N94-25678 \* # p 153

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## REPORT DOCUMENT PAGE

|                                                                                                                                     |                                                             |                                                                                         |                            |
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| 16. Abstract<br><br><b>This report lists 132 reports, articles and other documents recently announced in the NASA STI Database.</b> |                                                             |                                                                                         |                            |
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Govt. Publications Library  
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Minneapolis, MN 55455  
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Federal Documents Dept.  
106 Old Gym Bldg.  
University, MS 38677  
(601) 232-5857 Fax: (601) 232-5453

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Columbia, MO 65201  
(314) 882-6733 Fax: (314) 882-8044

## MONTANA

**UNIV. OF MONTANA**  
Maureen & Mike Mansfield Library  
Documents Div.  
Missoula, MT 59812-1195  
(406) 243-6700 Fax: (406) 243-2060

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Lincoln, NE 68588  
(402) 472-2562

## NEVADA

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Reno, NV 89557  
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Newark, NJ 07101-0630  
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Govt. Publications Dept.  
Albuquerque, NM 87131-1466  
(505) 277-5441 Fax: (505) 277-6019

## NEW MEXICO STATE LIBRARY

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Santa Fe, NM 87503  
(505) 827-3826 Fax: (505) 827-3820

## NEW YORK

**NEW YORK STATE LIBRARY**  
Documents/Gift & Exchange Section  
Federal Depository Program  
Cultural Education Center  
Albany, NY 12230  
(518) 474-5563 Fax: (518) 474-5786

## NORTH CAROLINA

**UNIV. OF NORTH CAROLINA - CHAPEL HILL**  
CB#3912, Davis Library  
BA/SS Dept. - Documents  
Chapel Hill, NC 27599  
(919) 962-1151 Fax: (919) 962-0484

## NORTH DAKOTA

**NORTH DAKOTA STATE UNIV. LIB.**  
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Dakota, Chester Fritz Library  
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Columbus, OH 43266  
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Oklahoma City, OK 73105-3298  
(405) 521-2502, ext. 252, 253  
Fax: (405) 525-7804

## OKLAHOMA STATE UNIV.

Edmon Low Library  
Documents Dept.  
Stillwater, OK 74078  
(405) 744-6546 Fax: (405) 744-5183

## OREGON

**PORTLAND STATE UNIV.**  
Millar Library  
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Harrisburg, PA 17105  
(717) 787-3752

## SOUTH CAROLINA

**CLEMSON UNIV.**  
Cooper Library  
Public Documents Unit  
Clemson, SC 29634-3001  
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Carolina, Thomas Cooper Library,  
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## TENNESSEE

**MEMPHIS STATE UNIV. LIBRARIES**  
Govt. Documents  
Memphis, TN 38152  
(901) 678-2586 Fax: (901) 678-2511

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**TEXAS STATE LIBRARY**  
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Austin, TX 78711  
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## TEXAS TECH. UNIV. LIBRARY

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## UTAH

**UTAH STATE UNIV.**  
Merrill Library & Learning Resources  
Center, UMC-3000  
Documents Dept.  
Logan, UT 84322-3000  
(801) 750-2684 Fax: (801) 750-2677

## VIRGINIA

**UNIV. OF VIRGINIA**  
Alderman Library  
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